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STATUE OF PROFESSOR FARADAY.

THIS statue by the late J. H. Foley, R. A., was subscribed for by eminent persons in 1869, and Mr. Foley zealously devoted himself to the work, preparing first a very careful sketch model, afterwards executing an admirable bust, as his study for the head of the statue. But in consequence of Mr. Foley's failing health and his many other important engagements, the full-sized model was not far advanced at the time of his lamented death, on August 27, 1874. In accordance with his wishes, the work has been completed and executed in marble by his principal assistant, Mr. Brock. The statue is now in the hall of the Royal Institution, which is perhaps the most suitable place for it, since it was in the Royal Institution laboratory that Michael Faraday pursued his fruitful researches and made his important discoveries. The institution was also his hospitable home for upwards of fifty years; and it is still a meeting-place for the foremost workers in science of every nation, as it was in his lifetime. The statue represents Faraday in the gown of a Doctor of Civil Law of Oxford, holding in his hand the coil from which the first magneto-electric spark was elicited. It is universally admired as a work of art, and as a faithful likeness of the great philosopher.

NEW GUNBOATS FOR THE CHINESE GOVERNMENT.

OUR illustration represents one of four gunboats recently constructed in England for the Chinese Government. These vessels have been designed by Mr. George Rendel, of Sir W. G. Armstrong & Co.'s firm, and are a development of the well known Staunch type of gunboat, designed by Mr. Rendel for the British Admiralty. They are prototypes of an important class of war vessels, the value of which may be as yet but faintly appreciated. They are named after the first four letters of the Greek alphabet, the Alpha, Beta, Gamma, and Delta.

Two of the four Chinese gunboats carry each a 26½ ton Armstrong gun, and are now in China, having made their long voyage with armaments complete on board, ready for action, and with perfect comfort and safety; the two others, one of which our engraving represents, carry each a 12 in. 38 ton Armstrong gun, firing projectiles of 800 lbs., with charges of 130 lbs. of powder. These two guns are the most powerful guns yet afloat, and can penetrate 19½ in. of armor. Besides the great guns, the gunboats carry two Armstrong 12 pounders and a Gatling gun; yet they are only 115 ft. long and 30 ft. broad, and their draught is but 8 ft. and the freeboard 3 ft. Their displacement is 400 tons. Their engines have 270 horse power, and drive them, by means of twin screws, over nine knots per hour. They are schooner-rigged and tripod-masted, and carry coals sufficient to steam at their full speed for seven days of twenty-four hours.

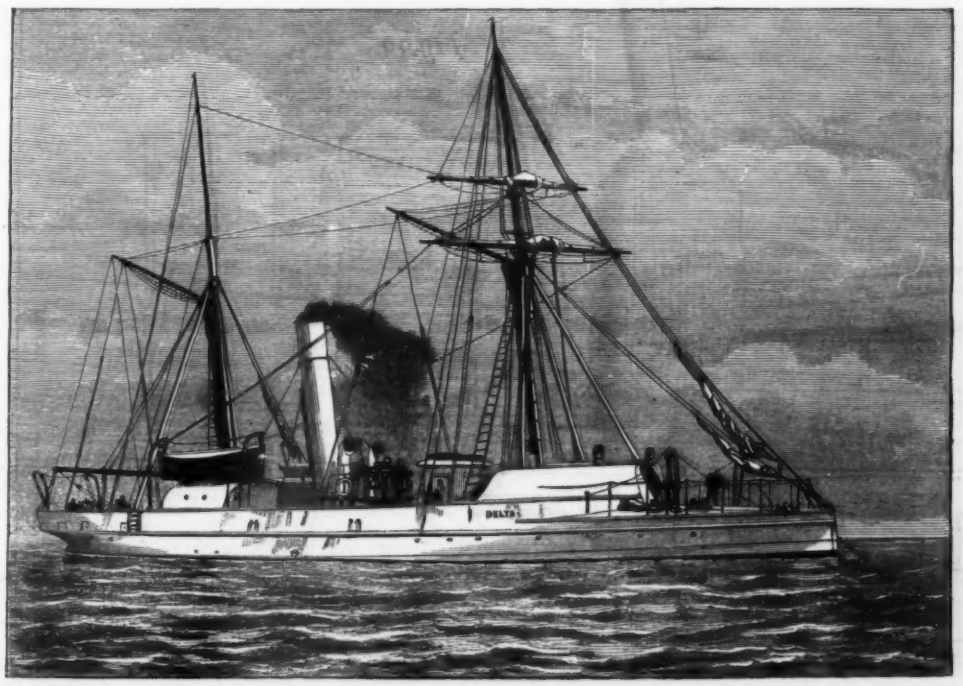
The enormous guns are mounted and worked wholly by hydraulic machinery, and the captain of the vessel, standing in a splinter-proof cabin just behind the gun, can aim it and work and fire it, at the same time steering the vessel and regulating its speed. The full complement consists of thirty men. The vessels have been tested and inspected under trial off the Tyne, and also off Portsmouth, by the chief technical authorities connected with the defences of the country by sea and land. The Chinese Ambassador and suite have also visited them, and the Envoy worked and fired the great gun at sea with his own hand. There is no question as to the importance of these small but powerful sea hornets.—*London Illustrated News.*

TORPEDO WARFARE.

THE Paris correspondent of the London *Times* sends to that paper the following notes on some recent interesting torpedo experiments with one of Messrs. Thorneycroft's spar torpedo boats:

"Some very interesting experiments were made a few days ago at Cherbourg with the little torpedo vessel called the Thorneycroft. It was the first occasion of testing in French waters whether a torpedo could be launched against a ship in full sail. Accordingly, Admiral Jaurez, who commands the squadron, ordered a disabled ship, the Bayonnaise, during a rather rough sea, to be towed out by a steamer belonging to the navy. A second-lieutenant, M. Lemoinne, was sent for, and informed that he had been selected to make the experiment of launching the Thorneycroft against the Bayonnaise while both were in full sail. He accepted the mission without hesitation, picked out two enginemen and a pilot, and went down with them into the interior of the Thorneycroft, of which only a small part was above water; this visible portion being painted of a grayish color, so as to be easily confused with the sea. The torpedo was placed so as to project from the bow of the vessel, at the extremity of which were two lateen sailyards about three meters in length. The towing steamer then took up its position in front of the squadron, and the Thorneycroft also assumed the position assigned for it; an interval of three or four marine miles separating the torpedo and the Bayonnaise. On a signal being given, both were set in motion, the steamer advancing in a straight line, and the Thorneycroft obliquely, so as to take the Bayonnaise in flank. The steam-tug went at 14 knots an hour, going at full speed in order to escape the Thorneycroft. The latter went 19 knots an hour, a rate not attained by any vessel in the squadron. The chase lasted about an hour, the squadron keeping in the rear, so as to witness the operations. At the end of that time the distance between the Thorneycroft and Bayonnaise had sensibly diminished, and at a given moment the former, in order to come up with the latter at the requisite distance, had to slacken speed to eight knots an hour. The whole squadron watched this last phase of the struggle with breathless interest, and people asked themselves whether the shock of the torpedo would not infallibly destroy the little vessel which bore it. It was feared that the lives of Second-Lieutenant Lemoinne and his three companions were absolutely sacrificed. However, the two vessels got visibly nearer. All at once the Thorneycroft put on a last spurt, and struck the Bayonnaise with its whole force on the starboard bow. The sea was terribly agitated, a deafening report was heard, and the Bayonnaise, with a rent as big as a house, sank with wonderful rapidity. As for the Thorneycroft, rebounding by the shock about fifteen meters off, even before the explosion occurred, it went round and round for a few moments, and then quietly resumed the direction of the squadron. No trace remained of the Bayonnaise; it was literally swallowed up by the sea. Unanimous plaudits greeted the courageous sailors as they joined the admiral's squadron to report on the mission they had accomplished. The experiment was repeated two days later, under the same conditions, with another disabled ship, and with the same success; and, in the opinion of competent men, this is one of the most decisive torpedo experiments which have yet been made. The little torpedo boat, with its lateen sailyards, resembles a small gray lizard, and is scarcely discernible in the water. It is evident that a single boat of this kind would be unable to approach an enemy's ship unless at dusk, or when it would be impossible to distinguish it at a distance, for had such an attack been attempted in broad daylight the Thorneycroft would manifestly have been knocked to pieces by the guns of the threatened ship before it could have carried out its project. On the other hand, it would be quite impossible for one or

STATUE OF PROFESSOR FARADAY IN THE HALL OF THE ROYAL INSTITUTION.



THE THIRTY-EIGHT TON GUNBOAT DELTA, FOR THE CHINESE GOVERNMENT.

A CHEAP STEAM YACHT. BY PADDLEFAST.

even several ships to defend themselves against a simultaneous attack, say, by twenty or twenty-five Thorneycrofts; and, as these cost only a fiftieth part of the expense of a man-of-war, this experiment presents a formidable problem to State navies. What is certain is that those who witnessed the affair were greatly impressed by it, and are persuaded that it is the starting-point of an inevitable transformation in naval tactics."—*Engineering*.

HOW TO BUILD CHEAP BOATS.

No. X.

BY PADDLEFAST.

A THIRTY FOOT STEAM YACHT.

Length over all ..... 30 ft.
Beam ..... 6 ft. 6 in.
Depth ..... 3 ft.
Diameter of Boiler, 3 ft.; height, 4 ft.
Diameter of Cylinder, 4 in.; stroke, 6 in.
Propeller, 3 bladed; diameter, 2 ft. 6 in.; pitch, 3 ft. 6 in.
Approximate cost of materials for hull, $120. Approximate cost of machinery, complete, made to order, $380.

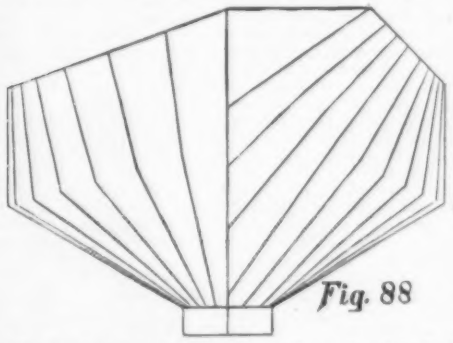


Fig. 88

The construction of this boat is similar to that described on page 1066, SUPPLEMENT No. 67; differing therefrom chiefly in the addition of an inside 1 in. ceiling, extending from *a* to *b*, Fig. 88. This ceiling is nailed to BB (Fig. 89), which are bolted to the apron A.

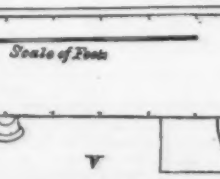


Fig. 89

In Figs. 86 and 87, A is the engine room and B the cabin. The engine room is about 3 ft. wide, and affords a space of 4 ft. or less between engine and boiler. On either side of engine room is a coal bunker, covered by a section of deck on a level with line C, Fig. 86. The cabin occupies the entire width of boat, and communicates with this deckway by the step *a*, Fig. 86, and a lateral sliding door. The cabin is open, with canvas sides and end, which are rolled down in stormy weather. A low bulkhead, *l*, excludes water from the cabin, and scuppers are cut through the sides, not only at *l* but at the lowest point of the bow flooring. These scuppers are closed by a flap or valve opening outward, to allow the escape of water but prevent its influx.

The pump may be placed on one side of engine. A small windlass is necessary on the bow.

STEAM-LAUNCH BUILDING.

MESSRS. YARROW & Co., the steam-launch builders, have just completed a screw tug, 60 feet long by 13 feet beam, for the Thames Steam Tug Company. Messrs. Yarrow are now very full of work, having in the course of construction ten small steamers. They comprise three high-speed steel torpedo steamers, 75 feet long, having an estimated speed of eighteen miles an hour; a steam yacht of 70 tons, for Colonel Dugat, of Paris; a steam launch, 50 feet long, for the Duke de Bagnara, of Naples; four small steamers for the Dutch Government, one of them a shallow-draught steel paddle boat, having a draught of only 7 inches; also, one fast iron steamer, 60 feet in length, for Siam.

THE VANGUARD.

THE London *Times* says it is probable that attempts will shortly be made to carry into effect the tender which has been accepted by the Admiralty for raising Her Majesty's ship the Vanguard. Under this contract the Government have the option of taking delivery of the ship when saved and brought into dry dock on payment of £175,000 to the contractors or of demanding from the contractors the sum of £20,000, and handing over to them the ship and all it contains. The contractors are now endeavoring to form a company, with a capital of £120,000, in 12,000 shares of £10 each, so as to be furnished with the requisite funds for providing salvage appliances for the work of lifting the Vanguard. The enterprise is an exceedingly bold one, and will, if successful in its result, be unparalleled in the annals of ship-raising. Indeed, it is the unanimous opinion of experts that with salvage appliances of the kind hitherto known and used, it would be impossible to lift the Vanguard from the bed of sand on which she lies. The rammer of the Iron Duke made a large hole in her side, through which for months mud and sand have been oozing into her, her water-tight compartments have long been filled with water, if not with mud, and it is more than probable that her bottom is broken, a calamity, however, not so serious as it might otherwise be, as she has a double keel. The weight of the vessel at present must be nearly 20,000 tons, but, of course, at a depth of twenty fathoms the weight for lifting purposes is much less. The depth of water, however, in which the Vanguard lies presents the greatest obstacle of all to any endeavors to lift her. The divers employed shortly after the vessel struck to cut away the masts, rigging, etc., were able and experienced; but they could never keep down for more than twenty minutes, even working on the deck. Since that time the vessel has been gradually sinking in the sand, and the depth from the surface to her keelson is nearly twenty-two fathoms The work of fixing pontoons to the sides of the ship or of passing chains underneath her could only be successfully accomplished if divers could work for an hour or two at a time; but at this great depth of water this is impracticable, owing to the enormous pressure of water and its suffocating effect on the diver. The salvage operations to be undertaken by the present contractors are, however, to be conducted with the newest appliances that modern science has suggested. Four pontoons of unusual size are to be constructed, each pontoon to have a lifting capacity of 3,000 tons, and the dimensions to be as follows: Length, 175 feet; breadth of beam, 50 feet

Fig. 86

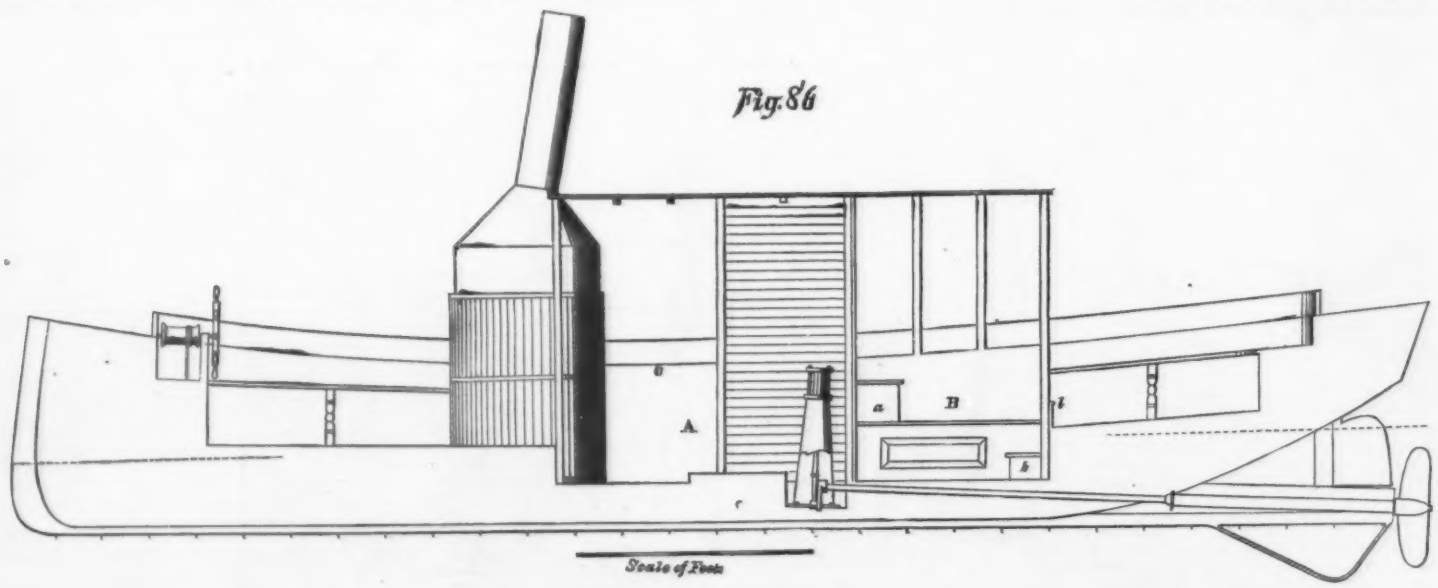


Fig. 87

A CHEAP STEAM YACHT.

and depth, 15 feet. They will be divided into forty-five compartments, and will be fitted with patent sluices and valves. There can be little doubt that in these four pontoons a lifting power sufficient to raise the Vanguard would be provided. But it will be a work of great difficulty to sink these huge unwieldy pontoons into position alongside of the wreck. This difficulty surmounted, the sand must be dredged away, and steel wires, which it is proposed to substitute for cables, will then have to be passed under the ship. If this can be done, the wires would be fastened to the pontoons, and all would be ready for lifting. But the wires could not be passed with divers working only half an hour at a time. A new inflated diving dress is therefore to be used, which dress is said by its inventor to shield the wearer from pressure even at a depth of twenty fathoms, and to enable him to work under water for more than 60 minutes consecutively. It will be seen therefore, that, unless the contractors exaggerate the value of the appliances they propose to use, they have at least a chance of overcoming the difficulties with which they have to grapple. The better to insure success, the salvage operations will be under the superintendence of Captain Coppin, of Glasgow, who has had a large experience in endeavoring to raise sunken vessels. Mr. W. Coppin, writing to the same paper, says: "The *Times* has given a paragraph on the raising of the Vanguard. There are some points to which I wish to call public attention. The ship has no keel, but she has a double bottom, strongly supported internally, and I cannot understand upon what theory it is supposed that her bottom is injured. I have had over thirty years' experience in ship-raising, and, with proper and powerful appliances, the operation of raising the Vanguard is by no means difficult, nor in itself very costly. Our shores are studded with valuable sunken ships and steamers, and in providing means for raising the Vanguard a want will be met which has been greatly felt and is very costly to the maritime interest of our country. It is simply a question of weight to raise and the providing of sufficient power to raise it. The weight of the Vanguard under water is about 5,000 tons; the Admiralty give the weight as 4,000 tons. The dimensions of the four pontoons are 175 feet by 59 feet by 18 feet depth each, capable of raising upwards of 12,000 tons with a freeboard of over 3 feet. The raising of the Vanguard will be accomplished by passing steel wire ropes under her bottom at distances apart of about 5 feet for the entire length of the ship. There are innumerable air and gun ports and various other means for fastening the ropes if additional means are required. After passing the ropes under the ship they will be fastened to a line of buoys on each side of the ship ready for being passed up through the tubes from the bottom to the deck of the pontoons, and the slack taken in by steam winches. Each rope will have a hydraulic index to show the strain, which is not to exceed 100 tons, although the breaking strain of each rope will be nearly 300 tons. The pontoons will be fitted with appliances for quickly lowering and raising them. Each foot of depth in the four pontoons, after their own displacement, is capable of raising 1,000 tons; therefore 5 feet will lift the Vanguard off the bottom, leaving a further lift of 8 feet every two hours for each operation, irrespective of tides. I calculate upon taking the Vanguard up the incline of the Kish Bank so that her decks will be above water within twenty-four hours after securing her to the pontoons. The diving operations will be conducted by means of a new deep-diving dress, the invention of Messrs. Tylor and myself, enabling the divers to remain with safety several hours under water at a greater depth than where the Vanguard lies. I visited the locality of the wreck of the Vanguard on the 14th ult., and carefully sounded her. She lies on hard sand, and I have no hesitation in saying that the interior of the ship (divided in so many compartments, nearly all closed) is comparatively free from sand or mud." Messrs. Siebe and Gorman, submarine engineers, write: "In Monday night's discussion upon the question of raising the Vanguard, the Government divers are spoken of as being shallow-water divers. This idea is entirely erroneous. In our presence, the Sheerness and Portsmouth trained men have descended in 120 feet of water and remained for a considerable time. The men in a very short space of time would be quite accustomed to the depth at which the Vanguard is sunk; but the difficulty to be overcome was the quantity of loose wreckage, wire ropes, etc., combined with a strong current. That is simply why the Government divers could not remain any length of time at work. The Whitstable divers are constantly working at depths varying from 90 feet to 130 feet, sending cargo out of ships' holds, but, of course, the men are trained for deep water, and while diving regulate their diet."

NAVIGATION.*

Rating of Chronometers.—The first important novelty we come to is the discovery by Mr. Hartnup, astronomer to the Harbor Board of Liverpool, of a system of rating chronometers, which gives an almost perfect means of compensating for change of rate due to change of temperature. It had long been known that no compensation balance could be made to keep time correctly through wide ranges of temperature:

"Thus the best chronometers of the best makers in modern times are practically perfect only within a range of 5° or 10° Fahrenheit on each side of a certain temperature, infinitely near to which the compensation is perfect in the individual chronometer.

"The temperature for which the compensation is perfect, and the amount of deviation from perfection at temperatures differing from it, are different in different chronometers. Mr. Hartnup finds that at the temperature for which the compensation is perfect, the chronometer goes faster than at any other temperature, and that the rate at any other temperature is calculated with marvelous accuracy (if the chronometer be a good one) by subtracting from the rate at that critical temperature the number obtained by multiplying the square of the difference of temperature by a certain constant coefficient."

Two chronometers recently carried from Liverpool to Calcutta, when rated on Mr. Hartnup's plan, gave a mean error of six seconds, while by the ordinary method the reckonings of Greenwich time from them differed by 4 minutes 35 seconds. The navigator could easily secure the advantages of Mr. Hartnup's system by noticing the temperature of his chronometer case daily, and entering a few figures in a note book. His work would be much facilitated if the thermometer used were graduated to squares of numbers of degrees from the temperature of maximum rate.

The Pressure Log.—The lecturer discusses at considerable length various modifications of the pressure log, the invention of Mr. J. R. Napier and Mr. Berthon, the principle of which is to measure the speed of the ship by observing to what height a column of water rises in a vertical tube, the bottom end of which dips into the sea and faces forward. It shows the ship's velocity through the water at any instant, instead, like all other logs, of telling the distance run during a known length of time. The latter piece of information is what is chiefly wanted for the purposes of ordinary navigation, but the former could not fail to be of immense use in the navy when ships are sailing in squadron. Even now, a rough approximation to a knowledge of velocity is got in the navy by the use of indicators showing the number of revolutions per minute made by the screw, and these satisfy very imperfectly the requirements of the case, as appears from the evidence given at the court martial on the loss of the Vanguard. The admiral signaled to the squadron that his ship was about to go at thirty-three revolutions, which he afterward explained to mean that he desired the squadron to go as nearly as possible at a speed of seven knots. Had each of the ships been provided with a pressure log, he might at once have given an order of whose meaning there could have been no possible doubt, and which it would have been perfectly easy for every ship to obey.

The Piano-forte Sounding Wire.—The taking of soundings to determine the depth is one of the most important of nautical operations. In surveys of the ocean's bed and for guidance in cable laying, soundings have to be made in great depths, often of several thousand fathoms. The trouble and time involved in taking a deep-sea sounding have been greatly reduced by Sir W. Thomson by the substitution of a single steel piano-forte wire for the hemp rope formerly used as a sounding line. The advantage of the wire is the comparatively small resistance it meets with in passing through the water. When hemp rope is used for sounding in deep water a weight of three or four hundred pounds must be attached to it, and even then it descends very slowly. When it reaches the bottom the weight is detached by a trigger, and is therefore lost. When wire is used a weight of about thirty pounds suffices; it descends very much more rapidly, and there is nothing to prevent its recovery each time. For very small depths such as are met with in the immediate neighborhood of land, the hand lead is convenient and sufficient, but there is a third class of soundings, those which are (or should be) made in depths of about twenty fathoms and upward when a ship is approaching land. To be able to take "flying" soundings—that is, to find the depth without stopping the ship—in any depth from 20 to 150 fathoms, is a matter of the greatest possible importance in ordinary navigation. Sir W. Thomson has succeeded in making it easy to do this, by the aid of his piano-forte wire in combination with another apparatus which he described at a recent meeting of the British Association. This consists of a pressure gauge of very simple construction, which is attached close to the end of the sounding line, and which, by registering the maximum pressure to which it has been subjected during immersion, registers the maximum depth it has attained. This indication is of course quite independent of the length of wire out, and is not affected by the fact that the ship is in motion. The pressure gauge consists of a small glass tube, of about $\frac{1}{10}$th inch bore, open at the lower end, but closed at the top. As this descends, the water rises in the tube, compressing the column of air. In order that a permanent record may be left of the maximum height to which the water rises, the interior of the tube is coated along its whole length with starch, in which red prussiate of potash has been dissolved, and just at the mouth of the tube are placed a few crystals of sulphate of iron which are held in position by an outer guard tube. The water which rises in the tube carries with it a little sulphate of iron in solution, and so leaves a permanent record of its height by staining the tube with Prussian blue. The system of sounding by wire has now had abundant trial, and its success is thoroughly established. Its author was, no doubt, quite within the limits of safe prophecy when he declared to the British Association in Glasgow that the old system of deep sea sounding by hemp rope had done its last work on board the Challenger.

Communication between Ships.—To communicate information from ship to ship by signals is an object of first importance to the sailor. By day, in clear weather and with skillful men, the system of flag and semaphore signals at present in use in the navy is very complete and effective. By night, in clear weather, Captain Colomb's method of flashing signals has been successfully used in the British navy for nearly twenty years, but its adoption has not been nearly so general as properly to meet the requirements of the case. On this point Sir W. Thomson says:

"The essential characteristic of Captain Colomb's method, on which its great success has depended, consists in the adoption of the Morse system of telegraphing by rapid succession of shorts and longs, 'dots' and 'dashes,' as they are called; and, I believe, its success would have been still greater, certainly its practice would have been by the present time much more familiar to every officer and man in the service than it is now, had not only the general principle of the Morse system, but the actual Morse alphabet for letters and numerals been adopted by Captain Colomb. A modification of Captain Colomb's system, which many practical trials has convinced me is a great improvement, consists in the substitution of short and long eclipses for short and long flashes. In the system of short and long eclipses, the signal lamp is allowed to show its light uninterruptedly until the signal commences. Then groups of long and short eclipses are produced by a movable screen, worked by the sender of the message, and read off as letters, numerals, or code signals by the receiver or receivers. . . . Whenever the light of a lamp suffices, the eclipse method is decidedly surer, particularly at quick speeds of working, than the flash method, and it has besides the great advantage of showing the receivers exactly where to look for the signals when they come, by keeping the signal lamp always in view in the intervals between signals, instead of keeping it eclipsed in the intervals as in Colomb's method."

The Morse Alphabet.—Is it too much to hope that before very long a knowledge of the Morse alphabet may form part of the elementary education of every boy and girl in the kingdom? Only then can the public awaken to a sense of the many uses to which such a knowledge could be put.

But there is a third set of conditions where signaling is more necessary as well as more difficult than in either of the other two. In fogs, by day or night, visible signals have to be given up as useless, and audible ones take their place. We may utilize Colomb's code or the Morse alphabet by giving short and long blasts on a steam whistle or fog-horn.

"But here again a very great improvement is to be made. Use instead of the distinction between short and long the distinction between sounds of two different pitches, the higher for the 'dot,' the lower for the 'dash.' Whether in the steam whistle or the fog horn a very sharp limitation of the duration of the signal is scarcely attainable. There is, in fact, an indecision in the beginning and end of the sound, which renders quick and sure Morse signaling by longs and shorts impracticable, and entails a painful slowness and a want of perfect sureness, especially when the sound is barely audible. Two fog-horns or two steam-whistles, tuned to two different notes, or when the distance is not too great, two notes of a bugle or cornet may be used to telegraph words and sentences with admirable smartness and sureness. Five words a minute are easily attainable. This method has the great advantage that, if the sounds can be heard at all, the distinction between the higher and the lower or, as we may say for brevity, 'acute' and 'grave,' is unmistakable; whereas the distinction between long and short blasts is lost, or becomes uncertain, long before the sound is inaudible."

The American Steam Siren.—To produce powerful blasts of sound differing from each other in pitch the Americans have devised an instrument which is much more effective than the fog-horn or steam-whistle. By the irony of fate sirens are now enlisted in the service of humanity, and no longer lure sailors to destruction. The reform in their morals, however, has been fatal to their romantic charm, for now they are "driven at a uniform rate by clockwork, and the blast is supplied from a steam boiler." But is the change to be regretted when we hear that:

"Short and long blasts of the siren might be advantageously substituted for short and long blasts of the steam whistle, but much more advantageously short blasts of two sirens on the same shaft, or on two shafts geared together, sounding different notes, acute note for the short, grave note for the long. The rapidity and the ready distinctiveness of character of the two notes will then be such that every officer and man will habitually recognize evolutional signals and signals for course and speed, just as in skirmishing every officer and private knows the bugle calls; and the signal book will be no more needed on the bridge of a ship of war than on the saddle of a field officer. When the admiral desires to alter speed or course for the fleet, his order will be given to the whole fleet simultaneously, and very nearly as fast as he can speak it to his flag captain, and then instantly (without waiting to open signal books) the other ships will, one after another in order, each in replying give the 'understand,' repeat the numbers expressing course and speed, and make her pennant. In as many quarter minutes as there are ships under his command, the order will have been thus securely acknowledged by every one of them, and the admiral will sound his signal announcing that the order commences to take effect. Nothing short of this in quickness and sureness of ordering the movements of a fleet ought for a moment to be thought of as tolerable, when it is certain (as it assuredly is) that so much is readily attainable."

* From a lecture delivered under the auspices of the Glasgow Science Lectures Association. By Sir William Thomson, D.C.L., LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow.

THE Society of German Railway Managers has offered nine prizes for important improvements in the railway system—viz., 7,000, 3,000, and 1,500 marks (mark=about 25 cts.), for inventions and improvements in the construction or building arrangements of railways; 7,000, 3,000, and 1,500 marks for inventions and improvements in the means of working, or in the management; 3,000 and two of 1,500 marks for inventions and improvements with regard to the control-management of railways and railway statistics, and also for the most important productions of railway literature. Communications may be made to the society's office in Berlin from 1st January to 15th of July, 1878.

CLEOPATRA'S NEEDLE.

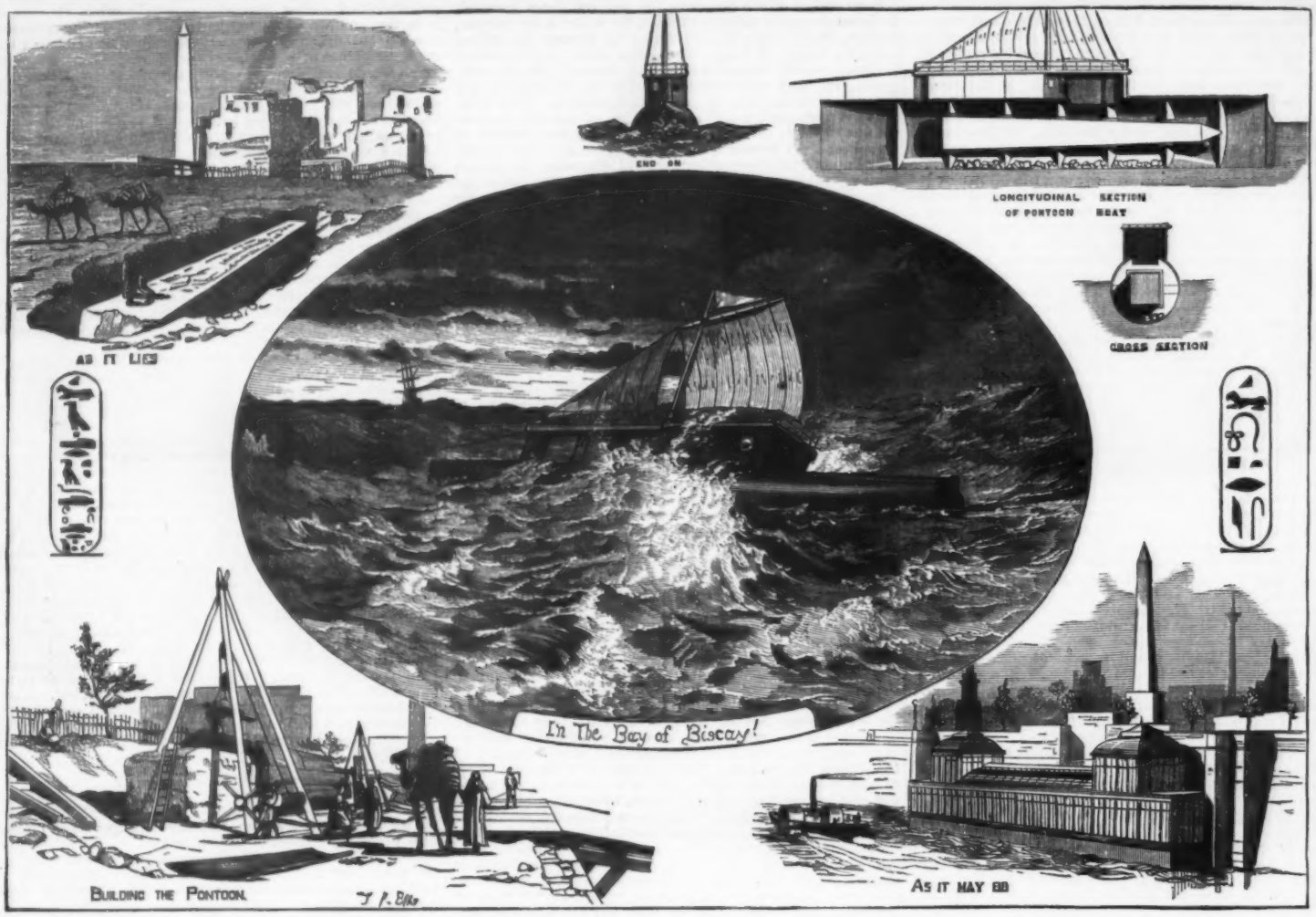
THIS obelisk of ancient Egypt, which has been left lying so long half buried in the sand at Alexandria, Egypt, is now about to be made an ornament to the city of London. Its removal has been considered a matter of such great expense that the British Government has not felt justified in undertaking it, and, had it not been for the private generosity of Dr. Erasmus Wilson and the ingenuity of the engineer, it would most likely have remained to form the foundations of the new houses leading to the Alexandria Railway Station. The cost of placing the French obelisk in the Place de la Concorde was £80,000, and though this included many little items of polishing and patching, the great bulk of the money was expended in the removal. The estimate in the present case is scarcely one-eighth of that amount. The obelisk was given by Mehemet Ali, Pasha of Egypt, grandfather of the present Khedive, to the British Government, about sixty years ago.

The consulting engineer is Mr. B. Baker, well known by his connection with the Metropolitan Railway, and the work will be performed by Mr. Dixon.

The removal of this obelisk will be accomplished in the following manner: A wrought-iron cylindrical pontoon, 92 feet long and 15 feet in diameter, tapered at each end to a vertical edge, as shown on a small scale in the upper right corner of our first engraving, will be its only support in the water. Larger views are given in our second illustrations. Its draught is 9 feet, and displacement 270 tons. If completely submerged, its power of flotation is equal to 705 tons, and as the weight of the obelisk is only 150 tons, with 80 tons ballast, it is evident that there is no chance of its foundering. The pontoon is furnished with a series of bulkheads, or diaphragms, which support the obelisk at about every 10 feet, and suitable elastic packing secures it from shocks. The obelisk is 66 feet long over all, and the base (8 feet 6 inches square) will be placed forward, about 20 feet from the prow of the pontoon, thus giving great buoyancy to the fore part, as the apex is close to the stern, which will be furnished with a rudder. At the top of the pontoon, and near its center, will be placed a small deck-house, with steering-wheel in the fore part, and accommodation for three men. There is a long, narrow hurricane-deck above the steering-room, and a short mast with two small sails surmounts the whole. This pontoon-boat will be perfectly water-tight and hermetically sealed, the only means of access being a small manhole in the floor of the deck-house. This will be securely fastened previous to the voyage, and only opened in case of emergency. The boat will be towed by a steamer to London, the sails being merely used for steadying purposes. It is calculated that the roll will not be excessive.

The obelisk as it at present lies is fortunately but a short distance from the shore of the Mediterranean; and the following is the proposed method of getting it inside the pontoon: A short length of the obelisk will be completely excavated, and the corresponding part of the pontoon will be built around it *in situ*. The obelisk being securely fixed to this part, so as to rest upon it, another length will be excavated, and another part of the pontoon built. In this way the whole of the cylinder will be constructed, with the obelisk securely fixed in the center. A roadway being then dug up to the sea-wall, and a short sloping platform made, leading into deep water (see illustration), the pontoon, with the obelisk inside, will be quietly rolled into the sea.

The deck-house, mast, and other fittings will then be added.



REMOVAL OF CLEOPATRA'S NEEDLE FROM EGYPT TO ENGLAND.

and the whole towed to England. The towing-rope (a quarter of a mile long) will be of wire. It will, of course, hang in a catenary curve in the water between the two boats, and any sudden shock or strain put upon one end will simply straighten the curve, and entirely ease off the effect of the other. Our illustration shows the towing-ship in the distance. It is expected that the speed will be about seven knots an hour.

Arrived at its destination (the deck-house, mast, and sails being removed), the pontoon will be rolled up an inclined plane out of the water and to its final resting-place. The method of raising is not yet decided, but no great difficulty is anticipated.

The question of the proper site is still undecided. The Board of Works has given leave to place it on the Thames Embankment, at the bottom of Northumberland Avenue. The objections to this are several and serious. From the east the apex will be hid by Charing-cross railway bridge. From the west the whole obelisk will be dwarfed by the huge railway station behind it; while from the river, except at lowest spring tides (as shown in the illustration), the base will be entirely hid by the new Floating Bath or Glaciarium.

Another site which commends itself far more is that proposed by the consulting engineer. In the ornamental grounds adjoining Westminster Abbey there is a spot commanded both by Victoria and Parliament streets; and if the obelisk were placed there it would not be dwarfed by the surrounding buildings, and it would form a fitting ornament to the beautiful gardens there.

The actual position of the obelisk, "as it lies," is seen in the sketch at the upper left-hand corner of our first engraving. There are two of those obelisks, of red granite, one standing erect, the other lying prostrate, and both are visible in the illustration. The upright one is 71 feet high; on one side the hieroglyphics are almost worn out, but on the other they are sharp and distinct. These obelisks are far more ancient than Queen Cleopatra: they bear the names of the old Pharaohs, Thothmes III., Rameses II., and Sethi II. The first of those monarchs reigned over Egypt in 1495 B.C., which takes us back nearly thirty-four centuries in the world's history, to the time of the bondage of Israel in Egypt. These obelisks stood originally in front of the Temple of Neptune at Heliopolis, and were brought, many centuries later, possibly by one of the Ptolemies or by Cleopatra, but perhaps by one of the Roman Cæsars, to adorn the palace built at Alexandria. One of the two was called Cleopatra's Needle, and the other Pompey's Pillar, but which is which has been a disputed question. The hieroglyphic characters figured at the sides of the page are not those to be found on the obelisk, but are copied from another inscription, of much later date, which bears reference to Cleopatra.

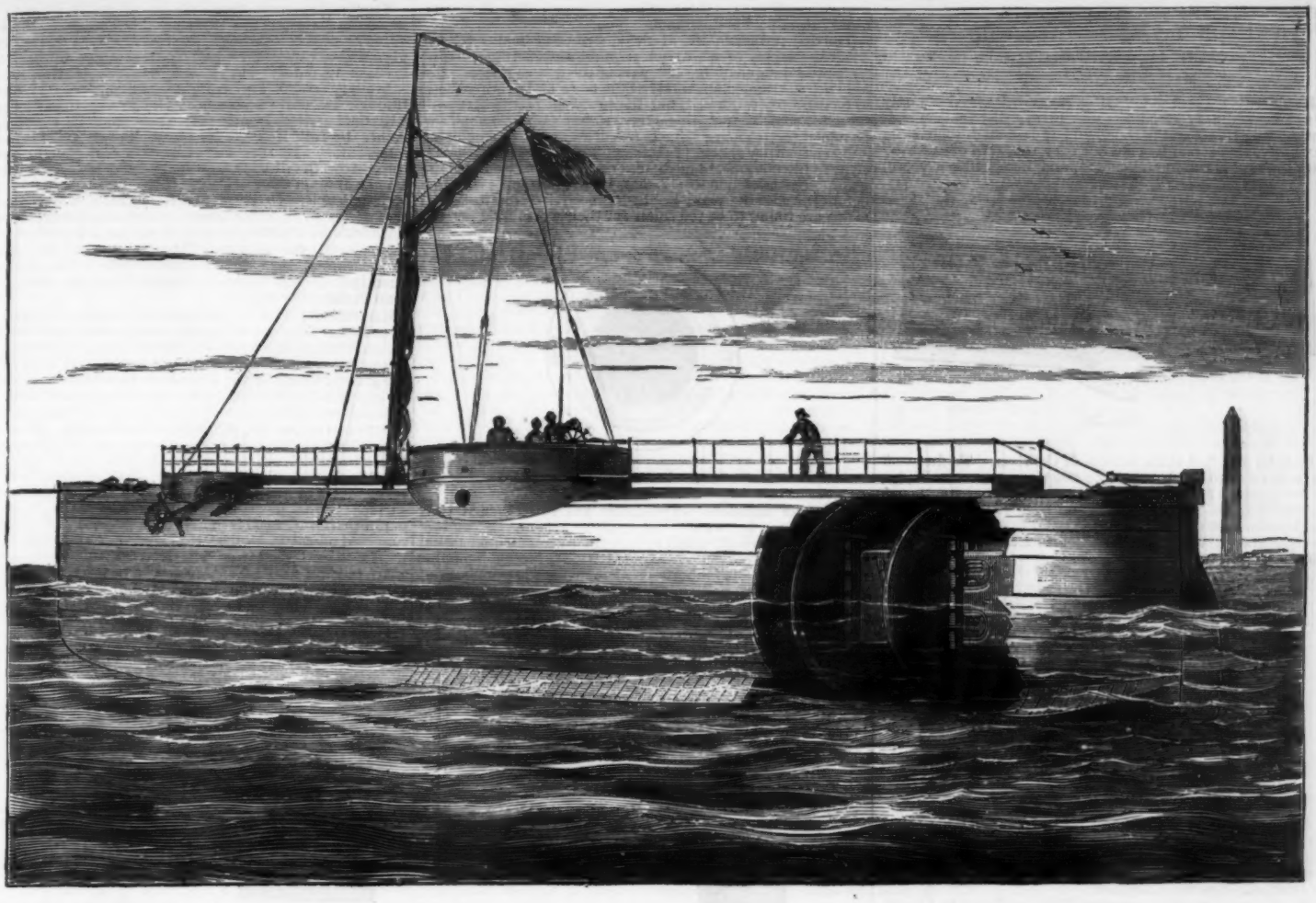
The vast size of these monoliths, varying in length from seventy to ninety feet, and weighing from 250 to 300 tons, has rendered them lasting proofs of the skill and industry of the ancient dwellers on the banks of the Nile. What excites our wonder is how, with the primitive appliances at their command, they could have achieved such stupendous results. They must have been a people not only of marvellous industry, but possessed of an amount of ingenuity and scientific knowledge only equalled in the present age. The first difficulty to overcome was that of cutting these huge blocks from the quarries, and this, it appears, was effected by means of metal wedges, which were struck at the same instant along the entire length of the stones; sometimes, however, the wedges were of highly dried wood, which, being driven into holes previously cut for them with a chisel, and then saturated with water, split the stone by their expansion. The mass, thus detached, had to be transported from the granite quarries of Syene to its destination, distant from Karnac 138 and from Heliopolis no less than 800 miles. This, according to Pliny, was managed by lashing two flat-bottomed boats together side by side, then admitting them into a trench cut from the Nile to the place where the stone lay, laden with a quantity of ballast equal to the weight of the obelisk, which ballast, as soon as they had been introduced beneath the transverse block, was all taken out, and the boats, rising as they were lightened, bore away the obelisk in lieu of their previous burden. Assuming the obelisk to have arrived at its destination, the next thing to be done was to get it into an erect position. This is stated by Sharpe, in his work on Ancient Egypt, to have been effected by first cutting a groove or notch in the stone intended to be used as a pedestal, so that while the obelisk was raised its lower edge might turn in that groove as a hinge. The obelisk was then brought on rollers till its lower end rested on this groove, and its head was then lifted up by a mound of earth, which was raised higher and higher till the stone which it leaned upon was set upright.—*London Illustrated News.*

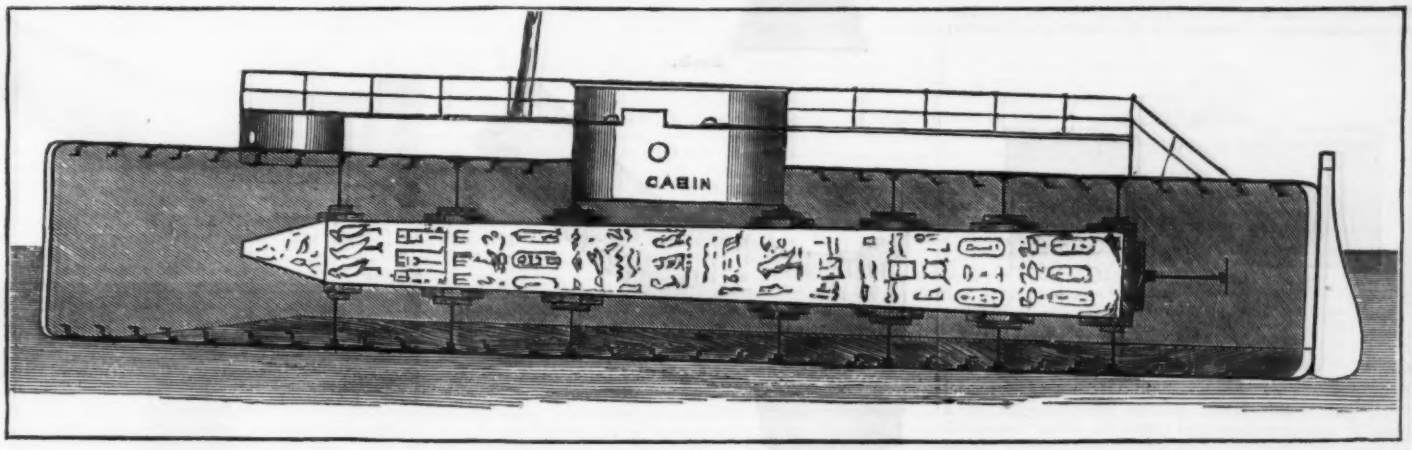
A MONUMENT OF THE PHARAOHS.

On the sea-shore of Alexandria are two giant splinters, which have been hewn out of the rock of rose-colored syenitic granite from the quarries of Syene, sculptured with inscriptions of three lines of hieroglyphs on each side, and transported from Elephantine to Heliopolis, where the pair stood before the door of the Temple of the God Tum, or the Setting Sun, at that third of the principal cities of Egypt on the Eastern frontier. Hence they were transported in the days of Cleopatra to the Cæsareum, or temple of Cæsar at Alexandria, and the modern appellation of Cleopatra's Needles retains the memory of their transfer. One of the giants "towering to the skies" has defied, for nearly 20 centuries, time and the spray of the Mediterranean, the other lies buried in the circumjacent sand, and it is now proposed—as will be seen in the report of the proceedings of the Metropolitan Board of Works in the London *Times* of January 20—to move it from its present place and erect it on a suitable site on the Thames Embankment. It is not the first time that the idea has been started, but the moment has come when it appears nearest to its realization. A private person, who—though it will be difficult for him to prevent it—does not desire his name to be connected with the matter, has shown what is, unfortunately, a rare example of public generosity by offering to contribute £10,000 for the conveyance of the giants to England. The agreement is signed, and all that remains is to commence the task. London will, therefore, at last have its obelisk. The puny modern specimens, not even monoliths, of limestone in Fleet Street and the Blackfriars Road, are hardly worthy of the name of obelisks.

The Egyptian obelisks in England are scarcely known; there is a miniature one of limestone in the collection of the Duke of Northumberland at Alnwick, another of red granite of Thothmes III., which formerly stood at Elphantine, but is now at Sion House, and a third of Ptolemy Euergetes II. and Cleopatra II. is at Corfe Castle. Two other obelisks of Nectanebes I., of small proportion but of fine material and execution, are in the British Museum. Obelisks were employed in Egypt from the earliest times, and dwarf examples were planted before the doors of sepulchres at a moderate computation 4,000 years ago. They formed a part of the sepulchre, standing before its door. They were made of a single piece of stone, and at a later period, and for public buildings, granite appears to have been preferred. They are squared columns, tapering slightly from the base to the apex, and the proportions of the base are one-tenth of the height of the shaft up to the base of the pyramidion or pyramidal top. This, at a later period, was capped with gold, copper, or iron. As early as the 12th Dynasty they passed from the decoration of sepulchres to the adornment of temples, and were erected before the pylons, or massive doorways, at that period the triumphal arches of ancient Egypt, the obelisks being in reality triumphal columns, like the Roman, only covered with inscriptions, not reliefs. The oldest extant is that of Usertesen I. at Matarieh or Heliopolis, and the most magnificent specimens were erected during the 18th and 19th Dynasties, after which others of inferior merit and dimensions were occasionally set up as late as the Roman dominion. It is to the period of Egypt's splendor, the summit of its power, and the reign of Thothmes III., the powerful monarch and conqueror, that the fallen obelisk of Alexandria belongs, and it was one of the triumphal columns raised by that monarch to record his victories over Asia and Ethiopia. The central line of hieroglyphs on each side the original dedication contains the name and titles of the monarch and records that it was erected to the god Ra, or the Rising Sun, and to Tum, or the Setting Sun, on the occasion of the Festival of 30 Years at On or Heliopolis. It is probably one of the obelisks for which Thothmes appointed a daily offering of bread and beer, as if it were a statue or living being, to be ever worshipped. The inscription states that it was capped with gold, but, of course, it has been stripped of that ornamental portion. How or when it fell is unknown; probably the effects of an earthquake or the undermining of the soil by the sea, to which it lies so near may have caused it to fall. The pedestal is still *in situ*, and at the base was found a dial showing that it had either stood in the Hippodrome or else served as a gnomon to the Cæsareum. In the days of Pliny both were erect, and he attributes them to Miphres or Moeris, the classical name of Thothmes III. It was, perhaps, not erected in his reign, for two lateral lines of hieroglyphs, one on each side of the central one, have been added by Rameses II., the heroic king, more familiarly known as Sesostris, who restored and elevated the monolith perhaps after it had been prepared for the purpose. The inscriptions, however, throw no light on this fact, as the phrases only record his conquests of the foreigners as far as the ocean and the poles of heaven, or that his glance annihilated his enemies, and that none dared to speak to his brow.

When the Emperors of Rome began to embellish the Eternal City with those spoils of vanquished Egypt, it is difficult to know why the two obelisks of Alexandria were left behind, except that as they stood in the Cæsareum, and were convenient landmarks, they might have been left as a monument to Cæsar and a guide to mariners. The last obelisk transported to Europe and set up in the Place de la Concorde at Paris was selected for its superior beauty and finer condition, the standing obelisk of Alexandria being rejected on account of its worn state, especially on that side which faces the sea. The idea of removing the fallen obelisk to England, as a memorial of the departure of the French from Egypt, was entertained at the beginning of the present century, and in 1801 the task was begun by the United Services. At that period the Earl of Cavan, who was in command of the forces left behind in Egypt, turned his attention to the prostrate monolith. The means of removal were laid down by Major Bryce, of the Engineers. The troops were invited to subscribe a certain number of days' pay for the necessary expenses, and the necessary funds





REMOVAL OF CLEOPATRA'S NEEDLE FROM EGYPT TO ENGLAND.

were cheerfully subscribed. One of the largest French frigates, El Corso, was purchased of the Prize Agents for the purpose, and a stone pier or jetty commenced to bring the obelisk through the stern port of the vessel and lay it on blocks of timber, forming a platform upon the keel. Midshipmen and working parties were told off and pay issued to them from the funds which had been contributed. Captains Lacon and Donelly superintended the work, but it was abandoned in consequence of orders from Lord Keith and General Fox, who held command of the naval and military forces in the Mediterranean. Fox held that the employment of soldiers on such a service was detrimental to their discipline and destructive to their equipments. Lord Keith thought it unbecoming to the navy to use its services for such an undertaking, especially as the crew of the transport must leave it should the vessel be in any danger of foundering. The attempt was consequently abandoned, and a bronze plate, commemorating the principal events of the campaign, was inserted in the pedestal of the obelisk. The inscription of the plate was prepared by General Sir W. Auchmuty and Colonel Montresor. The funds were returned to the subscribers, the plate and coins purloined by the Turks, and the pedestal was seriously injured. Subsequently, in 1819, Mehemet Ali presented it to the Prince Regent, and the gift was accepted by the British Government. The question of its removal was seriously entertained, but the estimate of its expense, £10,000, deterred the Government from the attempt. In 1851 the late Mr. Joseph Hume, great economist as he was, advocated in the House of Commons its removal, but the supposed expense, £7,000, appeared too great, and it was subsequently offered to the Crystal Palace, but declined. The Admiralty, however, sent to Alexandria to examine the shaft and report on its condition and the practicability of its transport to this country.

In 1852 it was examined by Mr. Scott Tucker, and a small fragment was brought to England and presented by him to the British Museum. In 1867 the subject of its removal was again brought under the notice of the Government, in consequence of a notification from the Khedive, who had let the land on which it stood to a Greek merchant; and as he found that the obelisk was a tenant that paid no rent, he desired its absence, and in default of that buried it under the earth. But the question of its removal was again brought forward in 1876 by General Sir J. E Alexander, and there is now every prospect of its being removed and being placed on an appropriate site on the Thames Embankment. The removal is to be undertaken by Mr. John Dixon, civil engineer, who, assisted by his brother, Mr. Waynmann Dixon, proposes the following means of transporting this shaft of granite: The sand is to be cleared away and the obelisk set square parallel with the existing sea wall. An iron cylinder, finished off to a chisel edge, with sufficient diaphragm to give it strength, is to be constructed round the obelisk, which is to lie in the long axis of the cylinder and to be wedged and calked where it passes through the diaphragms so as to divide the cylinder into water-tight compartments. The cylinder is to be 95 ft. long by 15 ft. diameter, and will have a draught of 9 feet of water when afloat. All being riveted water-tight, it will be rolled into the sea and across the sandy bed of the water till it floats. It will then be turned over and the man-holes at the top opened, and about 30 tons of ballast put in to keep the ends vertical, so as to act like stem and stern. It will then have two bilge keels, a rudder, light spar deck, mast, and lug sails attached, and be provided with an anchor and good chain cables, and, if necessary, a pump in case of leakage. The cylinder ship will then be fit to go to any port of the world with its freight, and in any weather.

The cost of this operation will amount to about £3,000. The obelisk in its case will be towed over during the summer months, and laid aside the Thames Embankment on a platform properly prepared for the purpose and lifted high enough to clear the parapet, and the bilge keels and other additions being stripped off, the cylinder will be rolled to the proposed site and then stripped off the obelisk, which will lie ready to be elevated to its pedestal, an operation which will be simply effected by means of a few balks of timber and two small hydraulic rams. The whole cost is not to exceed £10,000, and that of the obelisk at Paris is said to have been £80,000.

Such are the means proposed by Mr. Dixon for the transport of this obelisk to England. The entire height from the base to the apex is about 68 ft. 5 in.; it is 6 ft. 11 in. at the base, and 4 ft. 9 in. under the pyramidion. Four notches are in the corners of the base to hold tenants or cramps by which it was supported on its pedestal, or on some object which stood on its pedestal, but what they were is quite uncertain. They have been observed by different persons who have described the obelisk. The obelisk of Alexandria is the ninth in height of those known, and, although two of the faces have suffered by exposure to the sea, the hieroglyphic inscriptions are distinctly visible, and will, no doubt, be more so when the monolith is set upright, when there will be more shadow to throw them out. The mode proposed by Mr. Dixon for effecting its elevation on its pedestal is much more simple than that of Fontana, who transported and set up, in its present position in Rome, the obelisk which had been removed from Egypt by Caligual. Fontana effected the transfer by a complex system of 100 capstans, 800 men, and 80 horses, and this was considered at its time, A.D. 1588, a marvellous feat of engineering. The erection of the obelisk of Luxor, in the Place de la Concorde at Paris, was accomplished by the architect Le Bas, in 1833, by means closely resembling those employed by Fontana. English engineering proposes to effect the same object with a less cumbrous apparatus, and all the more powerful and simpler appliances of the 19th century.

It will have been reserved for individual enterprise to set up on the Thames Embankment this monument of the British Army, which might have been done long ago had not the prejudices of martinets of the United Services in 1801 arrested an undertaking which would have been a monument of their glory.

THE number of paper mills in the United States at the present time, according to Lockwood's Directory, is 994, and the number of firms 795. Of these 254 firms and 327 mills are located in the Eastern States, 328 firms and 360 mills in the Middle States, 155 firms and 179 mills in the Western States, and 58 firms and 68 mills in the Southern States.

[JOURNAL OF GAS LIGHTING.]

PIPES FOR GAS AND OTHER PURPOSES.

(Continued from SUPPLEMENT, No. 68.)

MAIN PIPES (*continued*).

KAY'S ball and socket joint (Fig 29) has been used not only under the ordinary circumstances of gas distribution, but for crossing rivers and harbors, and it is stated, such is its flexibility, that it can be paid out over the stern of a vessel after the lead is run in and calked; and, being like a chain,

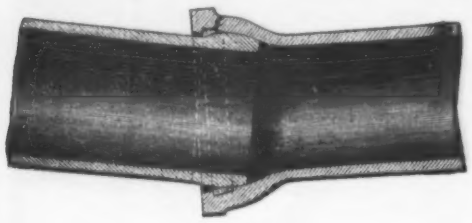


FIG. 29.

it finds its own bed at the bottom of the river. To draw off the water due to condensation or other causes, a small pipe of the requisite length is inserted through a hole in the accessible portion of the main, to the near end of which a hand-pump is attached. Both the latter description of pipes are manufactured by Messrs. Thomas Edington & Son, of Glasgow, Scotland.

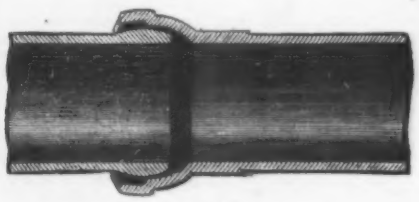


FIG. 30.

Another joint on the ball and socket principle, very similar to Kay's, is that of M. Doré, which will be sufficiently understood from the annexed Fig. 30. The space in front of the socket is intended to receive the lead, which is poured in and calked in the usual manner.

Mr. Warner's recently patented joint is shown in Fig. 31. This consists of a turned cylindrical spigot, fitting loosely into an ordinary open socket, having a groove cast round its inner circumference. The method of jointing is as follows:

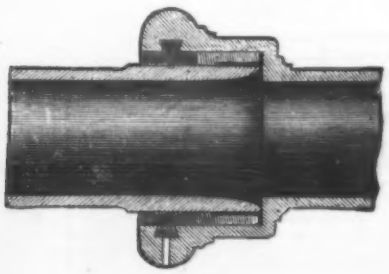


FIG. 31.

A flanged sleeve or sheath of thin sheet lead is placed over the spigot; this is then pushed into the socket, and a packing of spun-yarn is calked round it. After that a coil of greased yarn is inserted, and, a fence being placed against the lip of the socket, molten lead is poured through the hole on the top, as shown, filling up the groove and the intervening space. When this has been calked, the joint is complete. There are several modifications of the arrangement, but the above explains fully the principle of the invention. The cost of making this is more than that of the ordinary joint, but the patentee claims the superior advantage of great elasticity, without danger of leakage, from his method of connecting.

For repairing broken mains, Mr. Warner employs a thimble in two halves, so arranged that, on being placed together against the main, they slide into each other, and wedge themselves round the pipe, a piece of sheet lead being first placed over the fractured part. A packing of yarn is then inserted, and lead is run in, and calked on both sides.

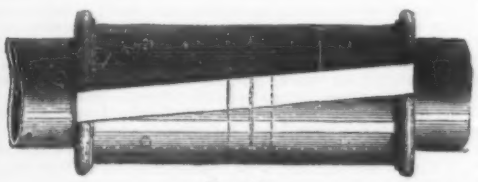


FIG. 32.

Fig. 33 is a longitudinal elevation of the thimble or collar, and Fig 33 a transverse section through the middle. The studs shown on the inner side of the collar are intended to add strength to the joint; or they answer as chipping-pieces that may be cut to suit the varying external diameter of pipes of the same bore. By the use of these collars, it is not necessary to cut out the broken pipe, as is done in the case of the ordinary thimble.

The following are the various forms of special pipes most commonly in use in the laying of mains: Fig. 34 is the ordinary quarter bend, with socket. Fig. 35 an elbow or knee-piece. Figs. 36 and 37 are eighth and sixteenth bends respectively. The latter are also called obtuse bends. Fig. 38 an S or double bend. Fig. 39 a Tee or branch-pipe. Fig. 40 the same, with the branch at an angle of 45°. Fig. 41 a saddle-branch and socket. Figs. 42 and 43 clip-branches. Fig 44 a diminishing pipe, and Fig. 45 the ordinary thimble, about 10 inches long.

The due proportioning of the distributing mains for the adequate supply of a district requires the exercise of foresight and judgment on the part of the gas engineer. Not only are the immediate wants of the town and neighborhood to be carefully estimated, but the probable requirements of these for some years to come have to be fully considered and provided for. The mistake is frequently made of canalizing a district with a system of mains of a size altogether insufficient to the obvious, immediate, or prospective wants of the place. The consequence is that, in a brief space of time, before the gas enterprise has had time to develop itself, the mains are found to be too small for their work. To remedy

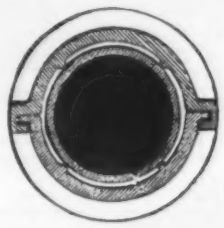
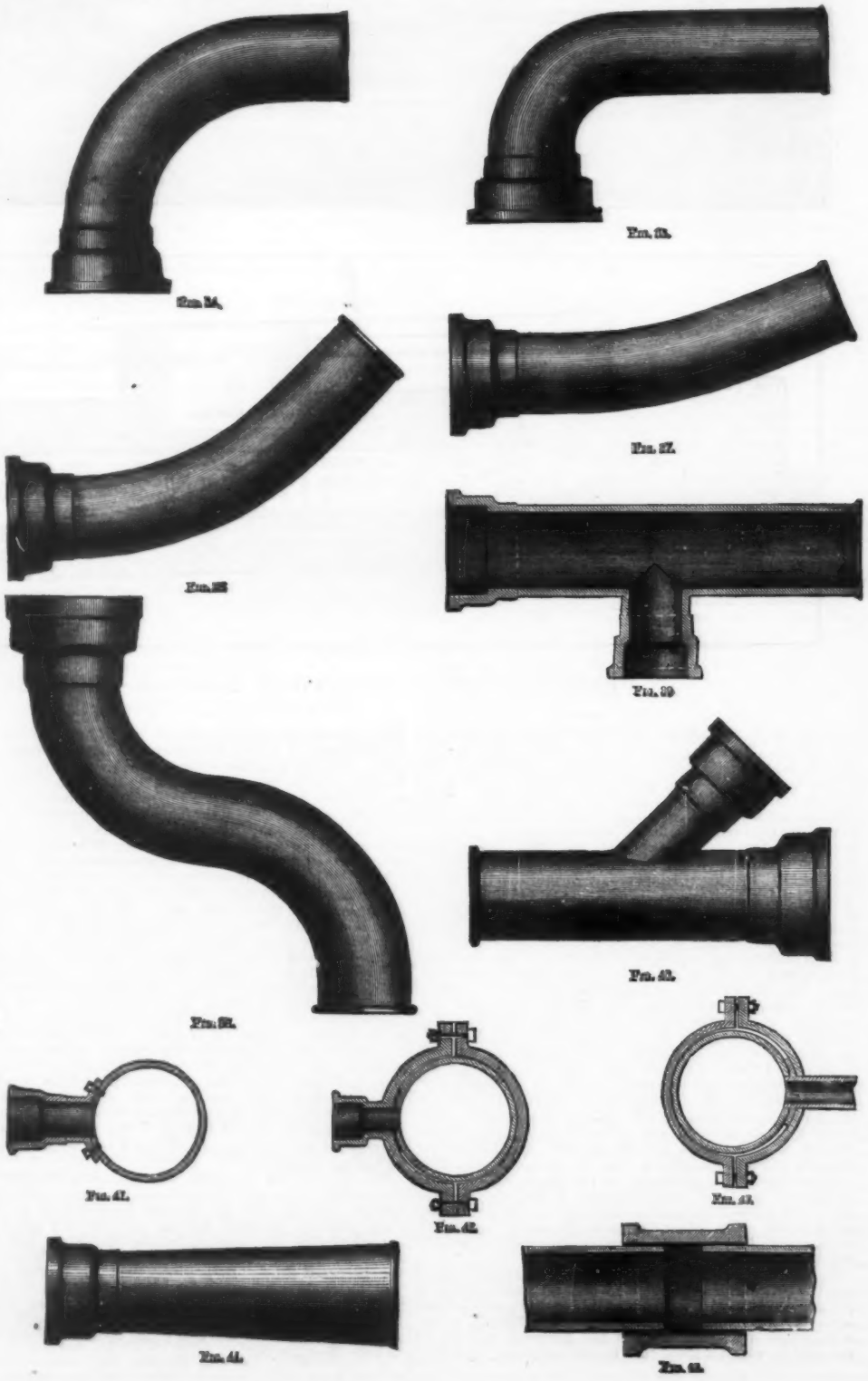


FIG. 33.

this evil, an additional expenditure has to be incurred for enlargements, by which the capital account is unduly weighted; or a resort is had to a gradually augmented initial pressure, resulting in widespread dissatisfaction amongst consumers in the neighborhood of the works, the amount of whose bills is materially influenced by the excessive pressure, whilst a growing leakage eats up from 30 to 50 per cent. of what might otherwise have been profit. This is no fanciful or exaggerated description; its counterpart, unfortunately, will occur to the recollection of most gas managers.

The leading main from the gas works is, of course, the largest in diameter; and this should be continued in as direct a line as possible through the centre of the district of supply, without any very sudden transition in size, to the furthest boundary. From this trunk or leading main, the subsidiary mains are made to branch in every direction through the various streets, and the experienced engineer will take care to insure that these shall be connected together, by full-sized branch pipes, at every possible point of intersection. By that means he will equalize the pressure throughout the district, and be enabled to employ a less diameter of main than without this mutual assistance would be practicable. In rural districts, with a widely extended area of supply, it is not always possible to connect the mains so as to form a network such as we have described; hence, as a rule, the mains have to be of larger size, in proportion to the supply, than in compactly built towns, and consequently their cost bears a greater proportion to the rental than in the other case.

Mains should, if possible, be laid at such a depth in the ground as to insure their not being materially interfered with by the weight of the traffic overhead, and the changes of temperature in the atmosphere. The depth of cover from the surface of the ground to the upper side of the pipe should not usually be less than twenty-one inches for the smallest mains, and those above eight inches in diameter should have a covering of two feet or two feet six inches in thickness. In countries where the extreme cold is more severe and of longer continuance than with us, they should be placed at a still greater depth. On the other hand, in tropical climates, where the temperature of the ground at a depth of two feet from the surface is equal to the mean temperature of the air, a greater depth than two feet is unnecessary. A good covering is rendered all the more desirable now that the steam roller is used in most large towns, and heavy agricultural steam engines in rural districts. The earth beneath the pipes, particularly if it has been disturbed and loosened, as well as that above, should be firmly rammed in so as to afford the pipes adequate support, without danger of settlement. No pipes should be laid in position without being first cleared of soil, stones, or other substances that may have got into it



accidentally, or been put there from *malice prepense*. With this object in view, the main-layer in charge of the work should personally examine every pipe when it has been rolled on to the cross supports over the trench. Neglect of this necessary precaution frequently leads to future expense and annoyance.

In wide streets it is advisable to lay two mains, one on each side. The first cost of doing this is considerably more than if only one were employed, notwithstanding that the [illegible] of each of the two would be smaller than the single one; but the expense of long services, and the leakage that is apt to arise therefrom, with other disadvantages attending their use, is saved, and this eventually compensates for the extra original cost incurred. In sparsely populated neighborhoods, the main should be laid on that side of the street or road where the largest number of services will be required.

Cast iron mains of less diameter than three inches ought never to be used. The difference in the cost of these and anything smaller is scarcely appreciable; whilst the loss of gas from fractures at the points of junction of the service-pipes occasioned by the weakening of the main in drilling, and the still more serious loss throughout the whole district that is entailed in having to maintain excessive pressure to afford the necessary supply of gas, are great and continuous.

THE RADIOMETER.

By Professor C. A. YOUNG.

THIS instrument, invented by Professor Crookes, has become so familiar to every one that it needs only a few words of description. It consists of a very light cross of aluminium wire, carrying four small vanes of aluminium, mica, or pith; these are blackened on one side and stand vertical. The cross is supported at its center on a delicate point so that it can revolve horizontally, and the whole is inclosed in a glass globe from which the air has been exhausted by a mercurial pump, producing a rarefaction far beyond the powers of an ordinary air-pump, though not by any means an absolute vacuum. If this apparatus be placed in the sunlight, or indeed exposed to a reasonably brilliant light of any kind, the vanes will revolve with a velocity depending upon the intensity of the light, and in the same direction as if the blackened surfaces were repelled by the light. In fact, this was Mr. Crookes' first idea; he thought he had demonstrated the *repulsive force of light*, and he made some very delicate experiments and elaborate calculations to estimate the amount of the repulsion exerted by the sunlight upon the earth's surface. It came out something enormous. These calculations, however, being founded on a misconception, are of no value, as Mr. Crookes now fully admits.

Different physicists have brought forward various explanations of the motion of the radiometer, some of them very ingenious and some of them very absurd; only one of the number, however, appears to be consistent with all the facts in the case. It is the one proposed by Frankland and Tait, founded upon the dynamical theory of gases, and thus far meets not a single contradiction in the observed facts. Indeed, the phenomena of the radiometer amount to something hardly less than an experimental demonstration of the truth of the theory referred to. Crookes himself, rejecting his original idea, fully accepts Frankland's explanation, and in his recent papers in *Nature* brings forward a number of new and extremely delicate experiments, which confirm it in every respect.

Our readers are probably aware that a gas, according to the dynamical theory, consists of separate molecules, unconnected with each other, which fly backwards and forwards in the containing vessel, and by their impact on its walls produce pressure. For the greater part of their course these molecules move in straight lines, but when they collide, or approach very near each other, they change their direction and velocity. The higher the temperature of the gas the more swiftly the molecules move; in fact, according to this theory, the temperature depends strictly upon the mean velocity of the molecules, which in hydregen gas at 32° F. is about 6,000 ft. per second, and in the case of air about 1,500.

The average distance which a particle will move between successive encounters will, of course, in this view, depend on the number of particles in a cubic inch, other things being equal. This distance is very minute, and, as the result of the experiments of Loschmidt and others, which it would take too long to explain here, is estimated, for air at common temperature and pressure, at about $\frac{1}{400000}$ of an inch. This is the average, but of course some particles will move much further and others a considerably smaller distance between successive collisions. If the density of the gas be diminished, the length of this "free path," as it is called, will evidently increase. We are, in short, to think of a mass of gas as pretty closely resembling a crowd of boys rushing about in an inclosed campus, quite heedless of the fences and of each other, except when they collide; our imaginary boys must be elastic, however, so that they will rebound on collision without damage, as unfortunately is not always the case with the real article.

Now for the bearing of this. When one surface of a thin plate of metal is by any means heated more than the opposite in an inclosure filled with gas, the particles which strike the warmed surface rebound with an increased velocity, and, if this were all, the plate itself would move back from the reaction. But it is not all. The rebounding molecules quickly collide with their nearest neighbors, and they in turn with others, so that the motion is communicated through the whole mass, and the cooler surface of the plate is struck with an increased vigor precisely sufficient to balance the reaction. A most refined and perfect, though somewhat difficult, mathematical investigation shows the balance to be exact, and that the equilibrium will be undisturbed so long as none of the particles rebounding from the heated surface reach the inclosing wall without encountering others.

But suppose the gas to be rarefied, or the wall so near that any considerable percentage of the rebounding molecules reach the wall without colliding on the way; then the reaction of the heated surface will not be balanced by a corresponding pressure on the other side, and the heated surface will be apparently repelled. That is all.

In the radiometer the rarefaction is carried so far and the inclosure is so small that a good many of the gaseous molecules, rebounding with accelerated velocity from the blackened surfaces, which are heated by absorption of the rays that strike them, reach the walls of the bulb and give up part of their energy there without distributing it to their companions.

Of course it follows that if the rarefaction be carried too far, that is, if the number of gaseous molecules in the bulb of the instrument be too much diminished, the instrument will work more feebly. Crookes (with others also) finds this to be the case, and what is more, and conforming exactly to the theory, the degree of rarefaction which is most effective differs according to the nature of the gas with which the bulb is filled, being much less for hydrogen, whose particles have a "free path" of great length, than for air. Again, the nearer the vanes in their motion come to the inclosing surface, the faster should be their motion, and this is found to be the case. Indeed, as said before, every known fact exactly agrees with this hypothesis which we have here tried to unfold in a popular and untechnical form.

Apart from all theories, it may be added that direct experiment has absolutely demonstrated that the motion of the instrument is produced by a reaction of some kind between the vanes and the inclosing bulb, and not by any impulse received immediately from the incident light as was at first supposed.—*Boston Journal of Chemistry.*

SIR WILLIAM GROVE ON THE RADIOMETER.

SIR WILLIAM GROVE lately described before the Philosophical Club some experiments he had recently made with a modification of Crookes' radiometer. After a few prefatory trials, such as coating one-half of the bulb with tinfoil and electrizing it, which gave no notable results, he devised a method by which he electrized the whole of the internal system. Four aluminium vanes, each blackened on one side, had metallic arms, and a metal point at their crossing that rested in a metal cup. The latter was united to a platinum wire that passed through a glass tube and was fused into it, the platinum wire protruding. Lastly, the glass tube was fused inside the apparatus and hermetically sealed, the end of the platinum wire being exposed. The vacuum in this apparatus was considered by Mr. Crookes to be as perfect as in his radiometers generally, but Sir William Grove doubted that it was so. The following were the results:

1. With the faint light of a lucifer match or of one or two candles, the vanes invariably turned the opposite way to the normal, the polished surface being repelled. With a dark heat, as from an iron shovel heated short of redness, they went the normal way. These effects continued for several days, but not permanently; the apparatus seemed to have leaked and to have become sluggish and irregular.

2. On electrizing the protruding platinum wire with a rubbed rod of glass or sealing-wax the vanes rotated sometimes one way and sometimes the other.

3. On connecting the negative pole of a Ruhmkorf's coil the results were uncertain, but the positive pole caused the vanes to rotate steadily, and its effect was even better than that from light or heat. In the dark the effect was very beautiful, as the dark vanes moved through a phosphorescent glow. The total results were considered by Sir William Grove to be somewhat negative, but they tended to show that all the effects were due to residual air. He suggested, in explanation of the last experiment, that more electricity would escape from the rough than from the polished faces of the vanes, as the former presented a vast number of points. Consequently the rough faces would produce more disturbance of the gas in front of them, and would themselves be more affected by the reaction than the plane faces. The polished surfaces being repelled by luminous heat is, however, very difficult of explanation.

In his second notice Sir William Grove described some further experiments he had made with Crookes' radiometers since the last meeting of the club. He did not now entertain much doubt that these movements are due to the effect of residual air. Mr. Crookes had kindly made a second instrument for him, and the one that he described at the last meeting, of which the vanes were metallic and in metallic connection with a platinum wire that protruded outside the apparatus, had been re-exhausted. Both now act normally, the black faces of the vanes being repelled by light and by heat. When the protruding wire is now electrized by a Ruhmkorf's coil, the effects that were previously observed are altogether absent, there is not the slightest luminosity round the vanes, and the current does not pass. But although the current is now incapable of traversing the small space of one-tenth of an inch that separates the vanes from the glass, induction acts across it just as well as before. This is shown by the readiness with which the vanes follow the movements of a piece of rubbed glass or sealing-wax held near the apparatus. It is, therefore, evident that the effects of attenuation of air upon discharge and upon induction are not the same. When attenuation has commenced and is increasing, the discharge passes more and more rapidly, until it becomes a glow, or, according to the old theory of electricity, polarization becomes more and more readily subverted; but further attenuation stops the discharge entirely. On the other hand, induction continues and appears to be in no way lessened by extreme attenuation. These results cannot be accounted for by the old theory that discharge is the consequence of subverted induction.

It further appears that a radiometer is a most delicate electroscope. By tilting it until the vanes touch the glass, the interior of the glass may be electrized, and it will then remain for days in that condition. He had performed this operation eight days ago, and the movements of the instrument by light or heat have been thereby wholly checked. Every endeavor has been made to discharge or neutralize the electricity on the glass surface, as, for example, by covering the exterior of the globe with tinfoil and connecting this with the platinum wire, nevertheless the glass remains charged, showing what a perfect insulator a good vacuum is.

The above is a copy of the abstracts in the club book. They are now further published, as some notices of them have appeared in foreign journals.—*W. R. G., in Nature.*

RECENT IMPROVEMENTS IN ANILINE BLACKS.

By M. ANTONY GUYARD.

SILK is, perhaps, the material most readily dyed, and that without any foregoing preparation other than cleaning. In general, a single immersion suffices to die the silk a magnificent black. It is advantageous to introduce into the beck a little gum, say 1 oz. per pint. The bath being thus slightly thickened, the silk, in a single immersion, takes up a large quantity of black, the color works on very even, and the silk preserves all its lustre.

The operation of dyeing aniline black with vanadium is so simple that, in fact, there is little to be added. It is, indeed, dyeing reduced to its simplest form—a single bath, without a mordant.

The spontaneous formation of aniline black under the influence of vanadium is so rapid that too large a quantity of the mixture should not be prepared at once. We may work in safety for about six hours with a mixture fully prepared, but a very simple arrangement renders it possible to work the same beck for an indefinite length of time.

For this end it is merely necessary to dissolve separately in large cisterns, holding about 110 gallons each, on the one hand, 176 lbs. muriate of aniline, and 3½ ozs. chloride of vanadium, or a smaller quantity of this salt.

In the other cistern are dissolved 77 lbs. to 88 lbs. chlorate of potash. These quantities will yield 218 gallons of standard aniline black dye.

We then run equal measures of these two liquids into a shallow beck, having either mixed them previously in an intermediate vessel, furnished with an agitator, and placed between the store tanks and the becks, or allowing them to mix as wanted in the dye-beck itself. We may thus work with great regularity, and without fear of preparing too large a quantity of the dye at once.

These details are of importance, because with the commercial salts of aniline the black is formed very rapidly.

I have, indeed, succeeded in preparing aniline salts, and in making vanadium mixtures, which would keep for entire days, or even entire weeks, or even indefinitely. But I do not think that this is of any great practical importance. Very active dye baths, skillfully worked, are still the best, and give the most satisfactory results. This is especially the case with baths into which the salt of Casthelaz has been introduced, for then the operations may be pushed on with a wonderful speed, and that which formerly took a week may be completed in a day.

The state of acidity, neutrality, or alkalinity of the alkaline salts has a great influence on the rapidity with which the black is formed, and also upon the tendency of the dye to weaken and often to destroy the tissues.

Acid salts form the black too rapidly, and the excess of acid greatly injures the fibre; consequently, they must be rejected.

Basic or alkaline salts are too slow; when mixed with chlorate and the vanadium salt they may be kept for days without the formation of aniline black. This apparent indifference is due to the fact that the oxide of vanadium is precipitated, and loses its power, in presence of an excess of aniline.

Fibres saturated with such dye containing alkaline salts, and placed in ageing rooms, are died black when the excess of aniline is evaporated, but much water escapes at the same time, and the vanadium being irregularly distributed upon the fibre acts too strongly in certain parts, and not sufficiently in others; the shade is irregular; and besides, as the action is produced upon a material too far dried, the action of the chlorine set free is too violent, and the fibres are readily destroyed at certain points.

The neutral salts, on the contrary, present neither the drawbacks of the acid salts nor those of the basic salts. The shade which they produce is beautiful and level, and they must therefore be selected for use. They answer all the purposes of the dyer; they do not tender the goods, and yet they enable the black to be readily developed, and when employed along with the preservative salt of Casthelaz the results are perfection itself.

Dyeing with aniline black is a matter of exceeding interest. It was a difficult and a delicate problem, but the reaction which I have just explained, and that of which I have still to treat, solve it in the happiest and most unlooked-for manner.

The introduction of vanadium aniline black in printing is, of its kind, a progress as well marked as the adoption of this same black in dyeing. The vanadium mixtures do not, in fact, contain any appreciable quantity of a metallic salt. The traces of chloride of vanadium introduced do not exert any chemical action upon the doctors of the machines.

To prepare the colors for printing dissolve from ¼ oz. to 1¼ oz. of an alkaline chlorate in 17½ fluid ounces of water (or say rather 8¾ ozs. to 13¾ ozs. in 8¾ pints), and thicken in the ordinary manner.

On the other hand, 17½ fluid ounces of water are thickened, and 2¾ ozs. muriate of aniline are stirred in along with 1½ grain of chloride of vanadium. The whole dissolves rapidly. Equal measures of the two pastes are mixed, passed through the strainers, and printed as rapidly as desired.

As the black is easily developed no more is to be mixed at once than is really needful, and it is also advantageous, as in dyeing, to age it at a low temperature as long as chlorine gas is escaping, and raise the temperature a little afterwards, until the patterns are completely dry. The pieces are then taken through bichromate of potash, and the operations terminated as usual. Nothing can equal the beauty of the blacks thus obtained.

In dyeing, the choice of the chlorates is without importance, and I admit that I have never obtained finer blacks than with chlorate of potash. The only inconvenience of the chlorate of potash is that it is not instantly soluble; hence a mixture of equal parts of chlorate of potash and chlorate of soda answers the wants of the dyer.

In printing, chlorate of potash is dangerous, as it is apt to crystallize on the surface of the color, when it blurs the design and soils the ground. Here, therefore, chlorate of soda should be exclusively used.

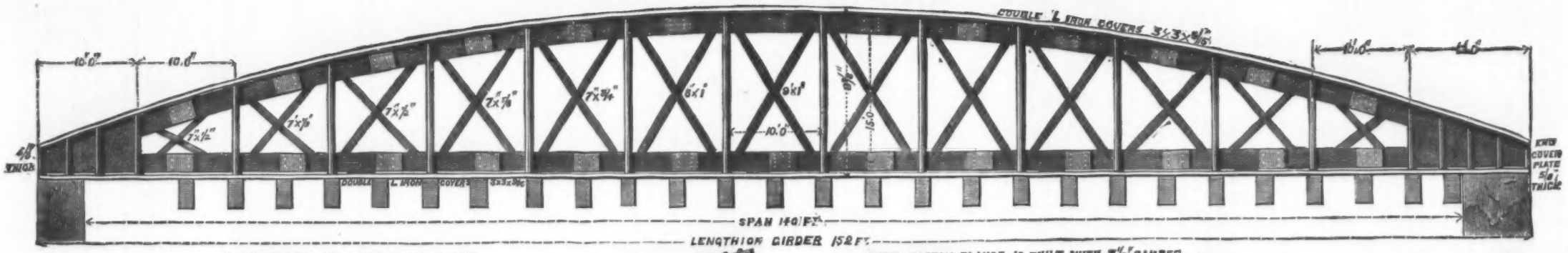
Aniline black with vanadium, therefore, is recommended by the extreme simplicity of the manipulations; by the perfect solubility of all the ingredients; by the ease with which the black is developed upon tissues or fibres, of whatsoever origin; by the beauty of the blacks obtained; and by the total absence of destructive action upon the steel doctors of the printing machines.

But although vanadium aniline black is the most convenient form in which aniline black can be applied in printing and dyeing, it must not be concluded that these mixtures remove all the difficulties inherent in its application. For if in its use we do not take all the ordinary precautions, we are exposed to grave accidents, even, in extreme cases, to the destruction of the goods, or to the formation of rings round the designs, which are difficult to hinder if the temperature of the ageing rooms is too high at the outset, or when the pieces are piled upon each other while still damp, or hung up too near each other in chambers insufficiently ventilated.

There is also a grand and important question, which the use of this black, taken alone, cannot solve; that is, the destruction of the colors already applied, and which the chlorine, liberated during the formation of the aniline blacks, may greatly impoverish or destroy altogether.

The solution of these two important problems, the absolute protection of the fibre against the action of chlorine and free acids during the formation of aniline black, on the one hand; and on the other, the simultaneous application and steaming of aniline black, has for a considerable time engaged the attention of the most distinguished chemists, and of the most skillful practicians.

The great apparent obstacle is, that all known preservative substances hinder the development of the black. The preservative salt, which has been sold for some time by the firm of John Casthelaz, appears to have solved the question. If a slow oxidation is desired, either in dyeing or printing, from one-half part to one part of the salt is used to one part of the aniline salt. For a rapid oxidation, or for the simultaneous steaming of aniline black and other colors, it is better to employ from one to one and a half part of the preservative salt to one part of the aniline salt.—*Teinturier Pratique.*



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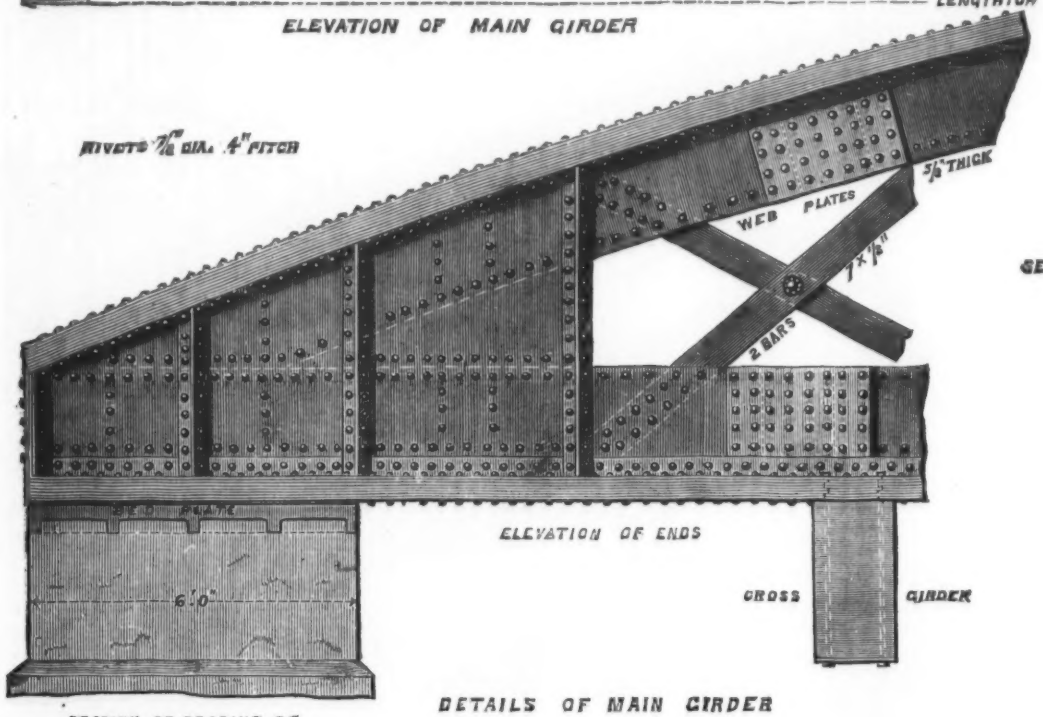
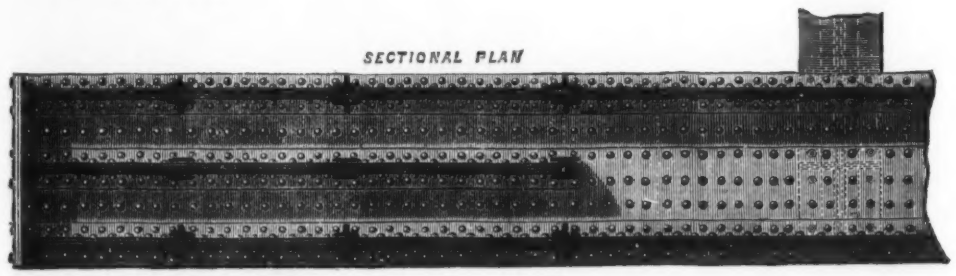


DETAILS OF MAIN GIRDER



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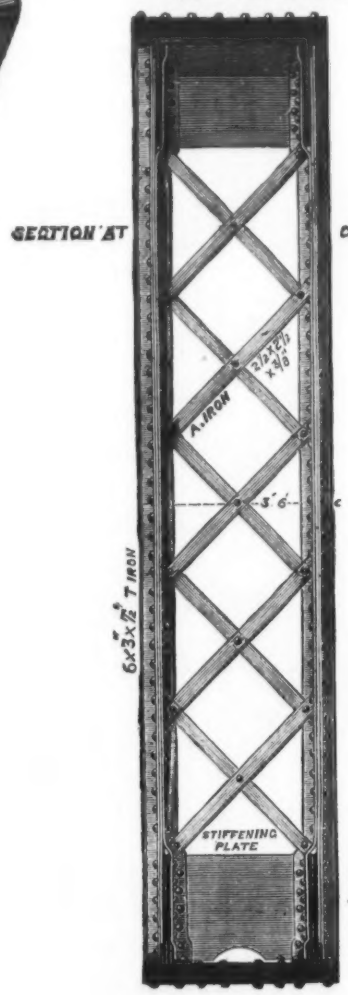
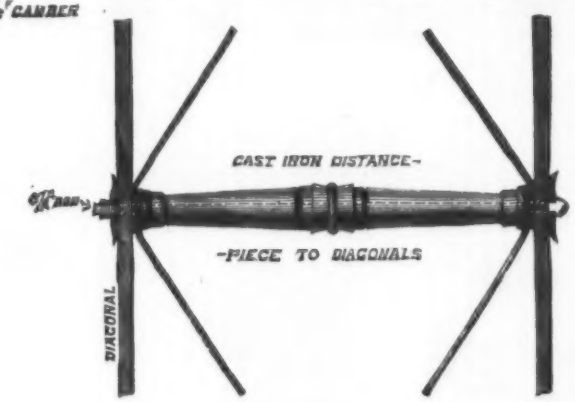
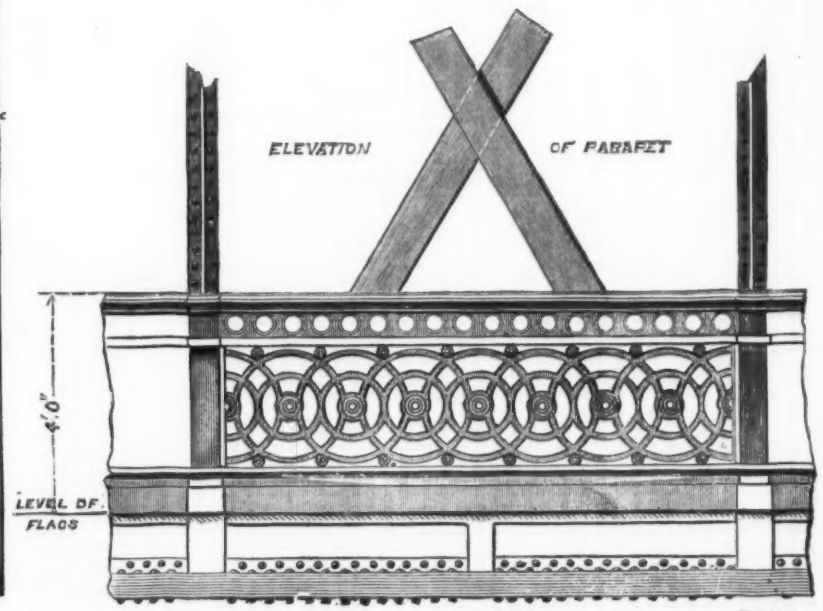
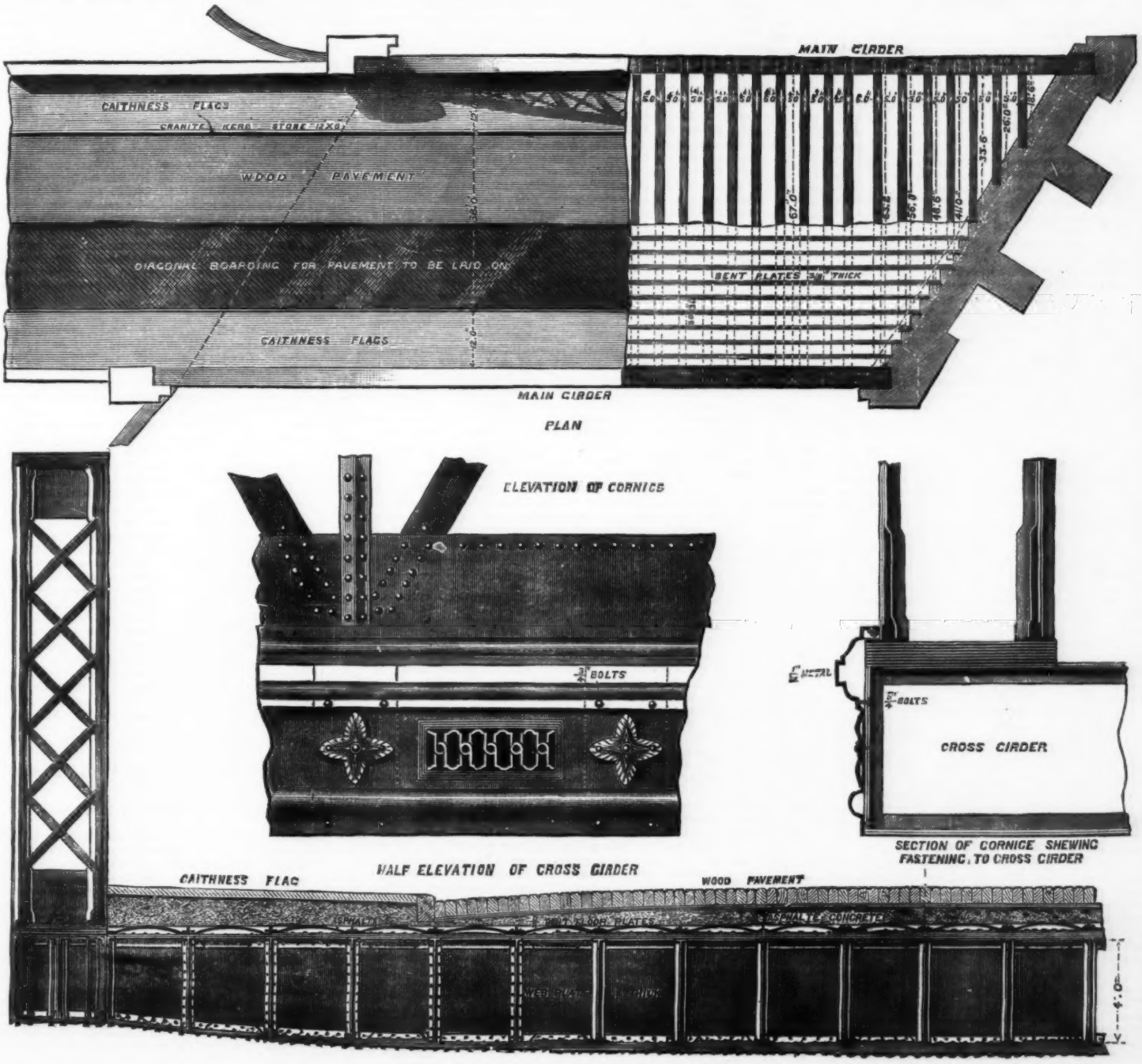






THROSTLE NEST BRIDGE. MANCHESTER, ENG.—A. FOWLER, ENGINEER.



THROSTLE NEST BRIDGE, MANCHESTER, ENG.—A. FOWLER, ENGINEER.

THROSTLE NEST BRIDGE, MANCHESTER.

AMONG the improvements recently effected, or now in progress, in Manchester, England, few are more deserving of attention than the bridges constructed across the Irwell. One of these, lately completed, we illustrate. It will supply an entirely new means of communication between Old Trafford and Salford. This bridge, constructed from designs by Mr. A. M. Fowler, the borough engineer of Salford, is an ornamental iron structure, suited for the heaviest traffic, and crosses the river by a single span of 140 ft.—the longest span, we believe, of any of the bridges over the Irwell It is a bowstring bridge, resting upon foundations of solid masonry, the materials for which have been procured from the Runcorn red sandstone quarries. The masonry work is executed by Mr. Abraham Pilling, of Bolton, whose tender amounted to about £13,140. The new bridge will be approached on the Salford side by a fine roadway, 60 ft. wide, leading from Broadway, South Cross Lane.

The bridge is placed on the skew. The width of available roadway between the main girders is 60 ft., viz., carriageway, 36 ft., and footway, 12 ft. wide on each side. The soffit of the bridge is 19 ft above the towing path, and 22 ft. 6 in. high above the ordinary water line. The two main girders are 152 ft. long, 17 ft. 9½ in. deep at the centre, and 3 ft. 6 in. wide, weighing together 320½ tons. The transverse girders are bolted to the underside of the main girders, and are 5 ft. apart, centre to centre, and 4 ft. 4 in. in total depth, and weigh 9 tons each. The total weight of the cross girders, including the short jack girders, is 239 tons. The ends of the transverse girders will be covered by an ornamental cast iron facia plate planted on. The floor is formed of curved boiler plates ¾ in. thick, supported on T irons, the spandrils being filled in with asphalt concrete. The floor plates weigh 60 tons. The carriage-way will be formed on the Improved Wood Pavement Company's principle, and the footpath will be formed of large Caithness flags. The bridge, however, is prepared for heavier pavement. The bridge will be fenced by an open cast iron railing of an ornamental character, surmounted with the Salford arms at each corner of the structure. The pilasters of the bridge will be surmounted by three ornamental lamps at each corner. The abutments are constructed of Runcorn stone, with bed stones, string courses, and caps to pilasters of stone from the Horsforth Wood quarries, near Leeds.

Messrs. Bellhouse & Co. are the contractors for the iron-work, at £11,832 15s. 8d.—*Engineer.*

POSSIBLE IMPROVEMENTS IN MARINE PROPULSION.

THE few experiments worthy of notice, which have been undertaken to determine the efficiency of existing systems of marine propulsion, have shown that it is probable that in the great majority of instances 50 per cent. of the whole power developed by a marine engine is not utilized in forcing the ship through the water; while even under the most favorable conditions it is certain that at least 40 per cent. of the gross power is lost. The sources of loss may be classed under two heads—machinery friction, and inefficiency of the instrument of propulsion, paddle, screw, or turbine. If it could be shown that the enormous losses to which we refer were unavoidable, then engineers would do well to rest content; and it would obviously be waste of time to contend with natural conditions which present insurmountable obstacles to progress. There is reason to conclude, however, that although power must, under all circumstances, be in a sense wasted or lost when ships are propelled by steam, the waste or loss may be reduced; and the margin within which improvement may be effected is so large that even a comparatively small amelioration may prove of great importance. The patents taken out for novelties in propelling apparatus are comparatively few in number; and they are commonly remarkable for the total ignorance of fundamental truths displayed by the patentees. It may be well to explain here that it is quite impossible in the present day to effect any improvement in marine propulsion unless the would-be improver brings to his task a consummate knowledge of the subject with which he proposes to deal. It was not always so, and very important inventions in marine propulsion were made by men who knew but little of the laws of motion in liquids and of liquids. It will be found, however, on examination, that there is nothing unique in this circumstance. Whenever a new process or mechanical operation is called into being, it is certain to be at first so imperfect that it is hardly possible to make a change which will not be for the better. Consequently, no very abstruse knowledge is required by pristine inventors. But as time progresses and obvious deductions become converted into practical modifications on previously existing modes of working, the machinery or the process grows more and more perfect, and at length a point is reached beyond which no one can go who is not fully armed with all the data and information which it is possible to obtain concerning the machinery or the process in question. For example, the first atmospheric engines ever made by Newcomen were so incomplete that no great effort of genius or considerable mechanical knowledge was required to design gear which would work the cocks automatically, as was done by Humphrey Potter. But the difference between applying strings and weights to the handles of a couple of stopcocks, and designing an engine in the present day that will burn less coal than any other engine is absolutely enormous. The first improvement was effected by an ignorant pit boy who knew nothing about steam. The second task may be performed only by a man who is a perfect master of a most abstruse subject. In the same way, when we come to deal with marine propulsion, it will be seen that the idea of using a screw instead of a paddle-wheel might easily arise in the mind of a man of some inventive ability; but to devise a better screw propeller in the present day than any that has gone before, an engineer must be perfectly familiar with a dozen things of which such men as Smith were no doubt densely ignorant. It is for these reasons, possibly, that so little has been done of late years to effect improvements in marine propulsion A good deal of ingenuity has been wasted, however, in the attempt, and our object at present is to indicate as briefly as may be, and in the simplest language, the only direction in which it seems to be possible that any important advance can be made on existing practice.

It is obvious that the subject may be divided under three heads—(1) Improvements in the form of ships; (2) improvements in marine engines; (3) improvements in the instrument of propulsion. As regards the first point, Mr. Froude has done a great deal to systematize and add to the existing store of knowledge concerning the laws of liquid resistance. His experiments are unparalleled for their magnitude and their accuracy. But Mr. Froude has admitted that he is unable to tell shipowners how best to design their ships. It would seem, indeed, that the form of the solid of least resistance is one which is quite incompatible with the conditions under which ships operate. The celebrated cigar ship may be cited as an example of the only attempt made to combine theory and practice in this direction; and it is by no means likely that any considerable improvement, in the way of reducing resistance, can be effected on the best modern practice of the naval architect. We may therefore dismiss questions concerning the lines of ships for the time being. Again, as regards engines, it is well known that, considered merely as engines there is little room for improvement in the direction of economy of fuel referred to in the indicated horse-power; and whether there is or is not, the subject is one far too large and too frequently discussed in our columns to be dealt with here in any way. We began this article by pointing out that from 40 to 50 per cent. of the indicated power of a marine engine is in one sense wasted. This has nothing to do, be it observed, with the economical efficiency, or the reverse, of the engine. To make the point clear, let us suppose that an engine works up to 100 horse power. This represents 3,300,000 lbs. raised a foot high in a minute. Let the speed of the ship be ten miles an hour, or 880 ft. per minute. then, if the whole indicated power given out by the engine were available for propulsion, the thrust on the screw shaft should amount to $\frac{3,300,000}{880}$ = 3,750 lbs. But in very good practice the thrust would really be only about 1,875 lbs. Why should this discrepancy exist? Is it possible to reduce it? Answering the last question put, we may say that we believe that it is possible to reduce it, and it is to this reduction that inventors who care for such things must direct their attention if they would achieve anything worth notice. The answer to the first question is that part of the power is wasted in friction and part of it by the inefficiency of the propeller.

It is far from easy to say with accuracy how much of the indicated power of any engine is available for duty, and for this reason we believe that the internal resistance of steam machinery, especially in ships, is largely under-estimated. Attempts to arrive at the truth are sometimes made by detaching the propeller and taking cards from the engines worked at the regulation speed. Nothing can be more misleading than an experiment of this kind. All the frictional resistances are largely augmented when the propeller is at work; the valves are harder to drive, the friction on the slide valves is increased, the friction of the thrust block comes into play, the crank shaft bearings all have additional strains put on them, and the air pump and circulating pumps have more work to do.* There is always a tendency among engineers to undervalue resistances that they do not wish to exist, and which they have no means of determining; and for this reason among others we fancy that the frictional resistance of the compound engine in particular is not estimated as it ought to be. The frictional and momentum resistance of short stroke, short connecting rod, high-speed compound engines, cannot fail to be very great; and it is clear that some types of engines must be much worse offenders in this respect than others; but on this point we shall not dwell at present. Our purpose will have been served if we can induce marine engine builders to believe, first, that internal engine resistance is a direct and important source of waste of fuel and power; and, secondly, that every exertion should be made to reduce it as much as possible. Many engineers entirely ignore the point, and we have seen engines at work which we venture to think required 40 lbs. of coal out of every 100 lbs. burned merely to overcome their own internal resistance. If we assume that the loss is just half this, or 20 per cent., it will be seen that for every 100 horse power, indicated by a pair of marine engines, only eighty are left to drive the screw and so propel the ship.

It is in the action of the screw propeller, however, especially when badly disposed and unfavorably circumstanced for the performance of its duties, that the great source of loss occurs. We have on more than one occasion explained the theory of the action of a screw, a paddle-wheel, and a turbine, but it may not be out of place to refresh our readers' memories on the subject. The action of a pair of paddle-wheels, for example, has unfortunately been compared to that of the driving wheels of a locomotive; but in reality no analogy, save in appearance, exists. Numerous attempts have been made to do away with slip, which is regarded as a source of waste, and we have been told that, as a locomotive does not slip, neither need a paddle-wheel. Such crude ideas are based on a total misapprehension of the whole question. A paddle-wheel or screw propeller uses the water as a fulcrum, and a locomotive uses the rails for the same purpose. But a fulcrum must offer resistance. Now by what is at first sight a paradox, water is in one sense *incapable of offering any resistance to motion until it is put in motion.* If it were possible to make a paddle-wheel revolve in water, and yet not cause that water to move, then would the fluid manifest not the slightest trace of resistance. The statement we have put in italics lies at the root of the whole theory of marine propulsion, and we would especially enforce it on the memories of our younger readers. It may be argued that screws have been known to work without slip or with negative slip; that is to say, they went faster than the screw could drive them, but this is a phenomenon which in no way affects the question at issue. It results from the fact that ships with full stern lines drag a large body of water after them, and this impinging on the screw produces the effect in question, and, in addition, a great loss of fuel; because the work done by the hull in dragging the water is much greater than the dragged water can restore in the shape of thrust.

Having reached this point, we may proceed to explain how the efficiency of a propeller may be best promoted. It may be laid down as an axiom that *that propeller is the best, other things being equal, that drives the largest quantity of water astern in a line with the keel at the least velocity.* The arguments on which this proposition or axiom is based are very simple, and easily stated. The object had in view by the marine engineer when he designs his propelling machinery is obviously to obtain the largest amount of thrust with the smallest expenditure of power. Now the thrust is found by the following rule: Multiply the number of pounds of water operated upon in one second by the velocity with which that water is driven astern by the screw, or paddles, or turbine, and divide the product by the number of feet per second of velocity produced in a second by the force of gravity. The quotient will be the required thrust of the propeller. The thrust depends solely on the total change of velocity impressed on the water, and not on the steps by which the change is effected. To illustrate this numerically, let us suppose that a propeller drives astern 10,000 lbs. of water per second at a velocity of 40 ft.; what is the thrust? Then 10,000 × 40=400,000, and this divided by, in round numbers, 32, the velocity in feet due to gravity acting for one second, we have as a quotient 12,500 lbs. This sum multiplied by the velocity in feet per second of the ship, and divided by 33,000, will give the effective or useful horse-power.

If our readers have followed us thus far, they will have no difficulty in comprehending what follows We have seen what the effective work is. The lost work is measured in this way: To ascertain the power required to put any body previously at rest into motion, the well-known formula $\frac{W v^2}{2g}$ is employed, and by its use we find that the energy expended in driving 10,000 lbs. of water astern at 40 ft. per second is equivalent to 250,000 foot-pounds. In other words, in order to obtain a thrust of 12,500 lbs. in the way stated, we are compelled to expend as much power as would raise 250,000 lbs. a foot high per second. The rate at which the ship is propelled will be, other things being equal, approximately as the cube roots of the thrusts. But the maximum thrust which it is possible to obtain when 10,000 lbs. of water are, during each second, driven astern at the rate of 40 feet per second, is 12,500 lbs.; and no conceivable or inconceivable modification in the nature of the propelling instrument or apparatus can affect this fact. If more thrust is wanted, then either the weight of water moved, or the velocity with which it is moved, must be altered. There is no escape from the conclusion that the weight of water moved, and the velocity of the movement, are the only factors that can be used in ascertaining the amount of thrust. In practice, a less thrust than that stated may be obtained as the result of the imperfect action of a propeller, as we shall on another occasion explain more fully; but for the present it will be enough to say that it is impossible to obtain a higher return than that given by the formula placed before our readers. Although the thrust cannot be augmented, however, it can be obtained in return for a less expenditure of power than that stated. It will have been noticed that, while the thrust varies only as the speed at which the water is driven astern, the work done in obtaining the thrust varies as the square of the speed, the formula for energy being, not $\frac{W v}{2g}$ but $\frac{W v^2}{2g}$. Let us suppose that our screw drives astern double the weight of water, or 20,000 lbs. per second, at the rate of 20 feet, instead of 10,000 lbs. at the rate of 40 feet in the same time. It is evident that $20,000 \times 20 = 10,000 \times 40$. Consequently the thrust will be identical in both cases. It will be, as before, 12,500 lbs. But $\frac{20,000 \text{ lbs.} \times 20^2}{64}$ is a very different thing from $\frac{10,000 \text{ lbs.} \times 40^2}{64}$ While the latter represents, as we have seen, 250,000 foot-pounds per second, the former represents but 125,000 foot-pounds, from which it will be seen that, by doubling the weight of water thrown astern and halving its speed, we reduce the waste of power by 50 per cent., while leaving the thrust unaltered.*

Here, then, lies the great field for possible improvements in marine propulsion. What is required is a propelling instrument of some kind which will drive more water astern at a slower speed than any propeller yet used. Two things are essential to the success of such an instrument—in the first place, it must be adapted for use with ships of the usual form; and, secondly, it must be arranged that it can obtain plenty of "solid" water to operate upon. Mr. Griffiths, as it is well known, augments the efficiency of the screw propeller in no ordinary degree by providing tunnels through which the water may find ready access to the blades instead of being intercepted by the body of the ship, as is now the case.

It would extend the length of this article beyond reasonable limits were we to attempt here to explain more plainly the direction in which improvement may be sought. We shall return to the subject, and take the opportunity of pointing out some of the peculiarities of the turbine as a propeller. We have said enough concerning thrust to enable our readers to understand why it and sundry other systems of propulsion of a kindred character have proved inefficient. The turbine obtains plenty of thrust, but only with an enormous expenditure of power caused by the fact that it drives astern a smaller quantity of water and at a higher speed than any other propeller with which we are acquainted. We have, we hope, said enough to show that those who have a desire to improve on existing systems of marine propulsion have plenty of space in which to work. That some power must always be expended in sending water astern is certain, but there is reason to believe that too small a quantity is driven aft and at too high a velocity by all screw propellers now in use. Were it possible to produce a paddle-wheel which would be free from well known and absolutely insurmountable defects, we should have an instrument of propulsion superior economically to the screw. But we much fear that the ground has been too often and too carefully trodden in this direction for the modern inventor to make anything of the hint we have thrown out.—*Engineer.*

* Morin estimates the loss proper to the friction due to the load on an engine at about 7·5 per cent., which is probably far below the mark in many instances.

* This may be put in another way by saying that the thrust of the screw on the water is exactly equivalent to the thrust of the water on the screw, and the useful work, or that expended on the ship, will be represented by the velocity of the ship multiplied by the thrust, while the wasted work will be represented by the velocity of the water multiplied by the thrust. In the first of the foregoing examples we have, then, 12,500×40=500,000 as the lost power, while in the latter example we have 12,500×20=250,000, or one half as much.

NEW METHOD FOR DETERMINING REFRACTIVE POWERS.

By H. C. SORBY, F.R.S.

BY means of a small divided scale and vernier, which may be readily attached to any microscope, Mr. Sorby succeeded in determining the refractive powers of transparent substances to the second place of decimals. No previous preparation of the specimen is necessary in cases where two planes approximately parallel exist, one of them being moderately smooth. In other cases it is necessary to grind two such parallel surfaces. This invention will be of great importance to opticians, as it will be no longer necessary to grind a substance into a prism in order to determine its refractive power.

DETERMINATION OF CARBON IN IRON AND STEEL.*

By ANDREW S. McCREATH.

THE treatment which steel receives, and the uses to which it may be applied, are frequently determined by the percentage of carbon which it contains; and especially is this the case in the different steel-works in this country. The part which this element plays in the composition of steel is such an important one that a process for its accurate determination becomes an absolute necessity.

At the meeting of the Institute of Mining Engineers, held at Cleveland in October, 1875, Mr. John B. Pearse read an able and exhaustive paper on "Iron and Carbon Mechanically and Chemically Considered," in which he reviewed the history of the chemical work relating to carbon in iron. It will not, therefore, be necessary to go over this ground again and show that the processes hitherto used for the estimation or carbon are often tedious and generally very unreliable.

The Eggertz colorimetric test is now in general use in the different steel works, and, where properly conducted, seems to answer all the requirements for an intelligent treatment of the steel in the forge and rolling mill. As, however, the accuracy of this test is in the first place dependent on a correct estimation of the carbon in the "standard," it becomes an absolute necessity that we should have a thoroughly reliable method for ascertaining this.

It has been proved that in the ordinary process for the estimation of carbon, by dissolving the iron or steel in chloride of copper, a loss of carbon takes place, owing to the disengagement of certain carburetted hydrogen gases (C_nH_n); but, according to the investigations of Prof. Richter, this only occurs when the chloride of copper is not perfectly neutral. He therefore suggested the use of a double salt of chloride of copper with chloride of potassium, or, chloride of sodium. He found that these salts were easily obtained crystallized and perfectly neutral, and when the decomposition of the iron took place in these solutions under as perfect seclusion of the air as possible, there was not the slightest trace of the carburetted hydrogen gases given off, even though the reaction was hastened by warmth. Another great advantage obtained by the use of these double salts was that it was not necessary to use hydrochloric acid to remove the precipitated copper. In order to effect this, it was only necessary to use a considerable excess of the double salt. Indeed, in the first decomposition, if an excess of the double salt had been used under the application of heat, it frequently happened that no separation of copper took place, and that only cuprous chloride was formed, which remained as a soluble double salt in the solution. The action of this double salt, therefore, seemed to suggest a ready and safe method for the separation of iron and carbon. I made several experiments with the use of the double chloride of copper and potassium, and, while the results were thoroughly reliable, the solvent action of the salt seemed rather slow. I was therefore induced to try the double chloride of copper and ammonium, and this I found to work admirably and answer every purpose. By using a large excess of the salt, the metallic copper, which sometimes separates, is completely dissolved, thereby avoiding acid and consequent liability to a loss of carbon. The solvent action of this salt is such that three or four grammes of iron or steel can be completely dissolved in about fifteen minutes. Another advantage is that the iron can be used in coarse drillings, so that the liability to obtain an unfair specimen by rejecting the larger pieces may always be avoided.

The details of the process are as follows:

Thirty-six grammes of the double chloride of copper and ammonium are dissolved in about 120 cubic centimetres of distilled water; three grammes of the iron or steel are then accurately weighed off and added to the solution. Decomposition immediately takes place, iron and copper replacing each other. In order to aid solution, the mixture is frequently stirred, and after a few minutes a gentle heat may be applied. In about fifteen minutes the iron will be completely decomposed, and the excess of the double salt will have redissolved any metallic copper which may have separated out. At this stage of the process the solution is so neutral that upon being heated a thin film of iron oxide forms, but this can be easily removed by a few drops of muriatic acid, and the mixture is now ready for filtration. The carbon is collected in a small test tube about 7·60 centimetres long, and 1·50 centimetres internal diameter, the end of which is drawn out to a point 4 millimetres wide, and stopped first with angular pieces of glass, and then *loosely* with ignited asbestos.

A small quantity of hot water is first run through the filter; the solution is then added, and the residue washed with hot water until free from chlorides. It sometimes happens that a small quantity of basic chloride of copper separates out in the tube, but this is easily dissolved by a little of the double chloride solution, and the washing is continued till the residue is free from chlorides. To see whether any of the carbon passes into filtrate, mix the fluid with strong hydrochloric acid (to prevent the separation of any basic chloride of copper), and then dilute. By this means it is easy to recognize any particles of carbon. If the filter has been properly made, the solution filters very rapidly, and all the carbon is retained on the asbestos.

The carbon has now to be converted into carbonic acid, and the weight of the latter ascertained. To accomplish this several methods can be used. The transferring of the carbon residue is always attended with trouble, and there is even danger of losing some of it, so that a method should be used which avoids this objection. A modification of Ullgren's process answers this purpose very nicely. The carbon can be oxidized at once without being dried—an operation which is necessary when it is burned off in oxygen.

The apparatus used for this purpose is shown in the accompanying sketch. A is a tube filled with small pieces of caustic potash, and attachable to funnel tube B by a cork; B is provided with a glass tap and serves to introduce the acids. The flask C has a capacity of about 300 centimetres, and the wash bottle E, about 100 cubic centimetres; the latter is filled about one third with strong sulphuric acid. The U tube F, which has a height of 11 centimetres and an internal diameter of 1·25 centimetres, is filled with angular pieces of chloride of calcium (*free from lime*) to retain the last traces of moisture. The potash bulbs G and the U tube H are for collecting the carbonic acid. The potash solution used in the bulbs should have a density of about 1·27, and the quantity should be sufficient to nearly fill the three lower bulbs. The left arm of the U tube H is filled with angular pieces of caustic potash, and right arm contains small pieces of chloride of calcium. The bulbs G and the tube H are carefully weighed before being attached to the apparatus. All being ready, the small test tube D, containing the carbon residue, is transferred to the flask C, as shown in sketch. Three grammes of chromic acid are then dissolved in about 10 cubic centimetres of distilled water, and added to the flask C by means of the funnel tube B; add to the contents of the flask about 50 cubic centimetres of strong sulphuric acid (through funnel tube B), a small quantity at first, then mix the contents of the flask by shaking, and add the rest. Mix the contents thoroughly and heat the flask gently, so that the bubbles of gas do not pass through the wash bottle E faster than three to a second. When the gas has ceased to be evolved, boil the contents of the flask carefully for three or four minutes; then attach the tube A, remove the lamp, and open the tap of the funnel tube B. Having done this, attach an aspirator to the U tube H, and draw about four litres of air through the apparatus, not faster than three bubbles to a second. When the heat is withdrawn, it frequently happens that the condensation of the vapor is so rapid that the liquid in the wash bottle E rushes back into the flask C. In order to control this, it is advisable to attach a small compression cock I, and by this means all trouble is avoided. By this method, as described, an estimation of carbon can easily be made in an hour; and in steels, where the amount of silicium is very small, the carbon may be collected on a counterpoised filter, dried, weighed, and burnt off in a platina crucible. This will enable a number of experiments to be carried on at once; but, where the chromic acid method is used, a single estimation requires constant attention. The following are some of the results obtained by the use of this process:

Double chloride of copper and potassium, and oxidation with chromic acid, ·510, ·519, ·494, ·504, ·512.

Double chloride of copper and ammonium, and oxidation with chromic acid, ·490, ·502, ·500, ·510.

Double salt, and counterpoise filter, ·500 and ·510.

The double chloride of copper and ammonium works the quickest and gives equally satisfactory results.

I am indebted to Mr. Joseph Hartshorne for the accompanying sketch of the apparatus used.

*A paper read before the American Institute of Mining Engineers, New York, February, 1877.

SILVER-MINING IN NEW ENGLAND.

THE existence of the precious metals in New England is by no means a new discovery. Many years ago, a large deposit of galena was found and worked in Ossipee, N. H., and at a time when the ore had to be carted by oxen to Portland for shipment, and is said to have paid the owners a profit of several hundred thousand dollars. Another mine in the same locality has more recently been successfully worked, and large smelting and refining works built on the bank of the Silver Lake; but the death of the owner and the burning of the works put a summary stop to the business. Nor was the work resumed, the presence of zinc making the ore difficult to reduce. Every one has heard of the gold mines of Lisbon, N. H., and for many years copper mines have been productive of large dividends in Vermont. As early as 1697 the records of the town of Newburyport show the discovery of a body of limestone in Devil's Den, the working of which brought various minerals to light. And it is a matter of tradition that enough gold was once found there for the manufacture by a Boston jeweler of many articles of ornament. Still, no steady mining industry has ever been created in New England, and the discovery of silver in Newburyport was a great surprise to the community. It happened thus:

A man named Edward Rogers was out gunning one day, some six years ago, in the barren, rocky land long known as Highfield pastures. Sitting down to rest, he amused himself with breaking apart a rock, which the weather had half cracked open. The inside of the stone presented a bluish, metallic lustre, novel to him, and he put some pieces in his pocket, carried them home, exhibiting them to his friends. Ignorant of metallurgical knowledge, not one of these paid particular heed to these specimens except one, A. F. Adams, who, more curious or more long-headed than the rest, foreseeing a speedier road to wealth than by working his farm, quietly devoted his time in the Newburyport library to the study of such books on mineralogy as it afforded, and after a couple of years so spent, together with careful, though secret, explorations of the Highfield pastures, he made up his mind that there was more below than on the surface, and secured from the then owner, R. T. Jacques, twelve acres, covering what his studies led him to consider the most valuable, for the sum of $350.

After receiving a warranty deed of the property, he began his explorations more openly, obtained a good deal of float ore, and having blasted in one spot to a depth of six feet, found what was deemed to be the true vein by those competent to judge, numbers of whom were soon attracted to the spot by the newspaper reports of Adams' discovery. He was early joined by one W. W. Chipman, an old mining man, who, recognizing the probability of success from the surface indications, laid the matter before some of his friends, and Dr. Kelly, E. P. Shaw, and E. M. Boynton soon became the owners with himself of the Adams' purchase and the adjoining property lying on the same vein. No sooner had vigorous explorations of the prospect excited public attention, and the value of Adams' purchase from Jacques risen to an estimated value of $100,000, than the latter, under the advice of counsel, filed a bill in equity against Adams to compel him to reconvey the pasture lot to him (Jacques) on the plea that a valuable mineral property had been obtained as a pasture lot by misrepresentation. Jacques probably had no case, but as the undecided suit threatened to tie the property and its hidden values up in chancery, he was settled with by the associates, and received $35,000 to give a new conveyance. The enterprise was then incorporated under the name of the Chipman Silver Mining Company, and work was regularly commenced with proper machinery and appliances, and a shaft sunk to a depth of about 100 feet, with three levels running on the vein. A large quantity of fine ore was taken out, and the Chipman Company was on the high road to success; but about a year ago a large cash sum was offered for the property, was accepted, and the mine, together with about 2,000 feet on the lode, passed into the hands of the Merrimac Silver Mining Company.

The history of the Merrimac mine is in some respects quite an anomaly among mining enterprises. No assessment has ever been laid by any organization owning it; every person owning the property has sold to advantage, and the mineral taken from the mine has paid the cost of both exploration and "plant." The works now erected have cost fully $60,000, and the opening of the mine has cost at least $40,000 more; yet there has been enough taken from the mine in sinking the shaft to a depth of 250 feet, and mining some 1,500 feet of drifts and cross-cuts to pay the costs of so doing, without having stopped on the vein to any extent below the 36-foot level.

The mine is now opened for a working production of at least two years, there being, according to Professor Vinton, of Columbia College, some 40,000 tons of ore now in sight. And it is his opinion, and that of all mining experts and scientists who have examined the property, that greater values exist below, and that the mine shows every indication of being a staying one. The product of the mine has up to a few weeks since been concentrated on the premises and shipped in various directions to be smelted. The cost of freights and the profits necessarily paid others for smelting having materially reduced the net yield from what it should be, the company has lately determined to do its own work, and a furnace has just been erected for reducing the ore to low grade bullion, this being, after assay at the Government mints, a regular article of commerce, subject to none of the contingencies of guess-work of unsmelted ores. It is estimated that this will yield fully 25 per cent. larger net results. The company has been paying monthly dividends for some time past, and we are assured on competent authority that the dividends for the coming six months are now in the crib or on the surface, with plenty more in sight.

The President of the Company is Mr. William Woolly, an old and well known successful Bostonian. The Superintendent, Mr. Edgar Shaw, is recognized as an expert by all who have ever visited the great mines of Eureka, Nevada, which he superintended for three years. The directors are well known conservative men, who own their own interests as an investment, having paid liberally for what they own, and being fully satisfied with the good interest they are receiving and feel confident of continuing to receive. The mine is conducted on economical principles, purchases are made at the lowest rates, labor is cheap, miners receiving at the greatest $1.75 per day, fuel ready at hand, and, though the Merrimac ore is of above the average value, a much lower grade would pay handsomely.

There has been a good deal of wild prospecting in the vicinity of Newburyport by inexperienced persons, and much money has been needlessly wasted. No lode except the Merrimac has yet been worked enough to pronounce upon it as a true fissure vein, and no shaft (except those of the Merrimac Company) has been sunk below 50 feet. It is probable, however, that the great success of the Merrimac will now lead to systematic operations by experts in mining, and while we do not anticipate a Comstock in Massachusetts, we do believe that this mine has laid the foundation of a great, permanent, and paying industry in New England.—*Boston Globe.*

NEW TEXTILE INVENTIONS.

A NEW form of centrifugal machine is announced by M. Corron, who describes it as consisting of a circular disk of cast iron, mounted on a verticle axle, and revolving within an iron or wooden case. The disk is divided into several compartments by means of radial slips. The advantage claimed for the new arrangement is that all the threads are projected by centrifugal force in a perfectly horizontal direction, and parallel to each other, and unentangled; and, moreover, that they are equally dried. Another modification of the centrifugal machine is that of M. Beauduin, who enlarges the size of the ordinary metal machine, in order to introduce a tube through which high pressure steam is passed from a boiler in order to heat the compressed air which passes through the stuffs, and remove all remaining humidity.

M. Beidoux has produced a machine which combines the mechanical action of the centrifugal machine and that of hot air for the cleaning and drying of wool, or the complete drying of any other humid material, the object being the saving of time and trouble in transferring it from the centrifugal to the drying machine.

An improvement in a method in practice in France, to give suppleness to dyed silks, by M. Perinaud, consists in substituting for what are called brush cards, with short hairs, brushes with long hairs, vegetable matter, or fine wire, and in doing away with pressure on the silk by the adoption of great speed. In addition to this, a perpendicular scratching of the silk is produced by making each brush oscillate slightly on one of its ends. By the new arrangement all gummy and resinous matters are said to be readily removed, and the tissue made beautifully supple.

M. Durand describes a process for cleaning and bleaching wool, silk, feathers, etc., which consists in neutralizing the sulphuric acid employed by means of a combination of carbonates of lime and barytes, which are completely inert in themselves, and which, in presence of the acid, abandon their carbonic acid, and form insoluble sulphates, whether in hot or cold water. The bleaching is said to be more perfect than when the neutralization is effected by soda.

A new application of brushing cotton, woolen, flaxen, hempen, and jute yarns for warp, in the hank, and after having been impregnated with size of any kind, have been invented by M. M. Cahuzac et Fils. A bath being prepared with the proper quantity of size, the hanks are immersed and massed together in the hot liquor, then wrung out with force, and left in a heap to macerate for some hours; they are then placed on a perch, and brushed by hand, or placed in a brushing machine, specially arranged for the purpose.

Modifications of bobbin, net, and lace machines by M. Sival la Serue are thus described. They apply principally to "Leaver" machines, and are intended for the production of every kind of fabric now made by hand in ordinary looms, such as figured tissues, ribbons, Indian shawls, and tapestry. The means employed are: 1. All the threads of the warp are stretched straight, as in common looms. 2. The yarn of the bobbins, or chariots, make the weft in the same manner as the shuttle in the loom, and serve specially to connect the threads of the warp. 3. The yarns for figures, or embroidery of all colors, are mounted on independent bars, and are worked into the stuff as they pass, according to the pattern, on one or more threads, and then passing under the tissue, or under such and such threads of the warp, and fixing themselves in the yarn of the weft chariots, now to the right, and now to the left, at the moment these come to rest.

The following modifications in machines for platting laces are described by M. G. Wuppermann. The principal points are that a greater or less number of bobbins may be employed, as well as of crossing wheels, and the movements of the bobbins may be varied at will. By this system there may be as many regulating slides as there are crossings, and the platting is equal and regular, whatever may be the number of revolutions made by the bobbins. The arrangement consists in a system of springs which govern the movements of the bobbins, which are directed by a winged wheel, and of a system of slides which, interposing between two of these wheels with wings, prevents the bobbin from passing from one wheel to the following, and, consequently, compelling them to return from that point.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

Second Series.

No. VIII.

It sometimes happens that an object of very simple and apparently innocent form will, when we come to consider it closely with a view to its construction, prove to embody problems of considerable intricacy. An instance of this is found in the tin can shown in Fig. 49, which, casually seen, would appear to be a sufficiently commonplace affair. But when we come to make a drawing of it, we discover that it involves a case of intersection different from any yet presented; the body of the can is a frustum of a cone, and the spout is made up of two other conical frustra, one of which penetrates the body, the axes meeting. We have then not only to determine this curve of intersection in order correctly to represent the can, but to ascertain its form after development, in order to lay out the sheet metal for both the body and the spout.

And the finding of the intersection is a more difficult problem than any of like nature thus far given. Not, perhaps, in principle, since we have already explained the processes by which to find the forms of sections of cones when cut by planes, and it is clear that if we cut both cones by the same plane, the lines thus determined must intersect each other, if at all, in points of the required curve. But in the

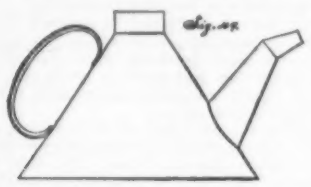


Fig. 49.

application we shall find greater difficulty than might at first thought be anticipated. Probably, the mode that would be most likely to suggest itself first, would be to use a system of horizontal planes, as shown in Fig. 50. These cut from the body of the can, whose axis is vertical, a series of circles, whose radii are given in the front view, and these lines are of course, sufficiently simple. But the axis of the other cone being inclined, these planes cut that surface in a series of ellipses. Now, it is not very difficult to determine these curves, but still it takes time, and the more, as they are all different. Consequently, although they will serve the purpose, they cannot be said to do so in a very satisfactory manner. We shall, therefore, try to find some readier means of solving the problem. Since in the case in hand the cones are surfaces of revolution, and their axes intersect, we can avail ourselves of the principle enunciated in Lesson V.: that if two surfaces of revolution intersect, the line of intersection will be a circle, generated by the revolution about the common axis of the point in which the meridian outlines cut each other. Referring to Fig. 32, we see this shown in the case of a sphere and a cone; and in Fig. 51 we illustrate its application to the problem under consideration. The axes cut each other at *C;* and, if we make this point the center of a sphere large enough to be penetrated by both cones, the line of intersection will in both cases be circles, because the sphere is a figure of which any diameter may be considered as an axis.

Let the circle *l p m r* be the outline of such a sphere; intersection with the vertical cone will be seen edgewise in the front view as *l m*, and in the top view as the circle whose radius is *Cl*. The intersection of the sphere with the inclined cone will also be seen edgewise in the front view as *p r;* in the top view this circle would appear as an ellipse, but it is not necessary to draw it. Because it is evident that as *l m*, *p r*, represent two planes perpendicular to the paper in the front view, the point *o* represents the line, also perpendicular to

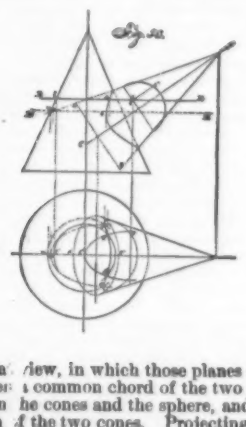


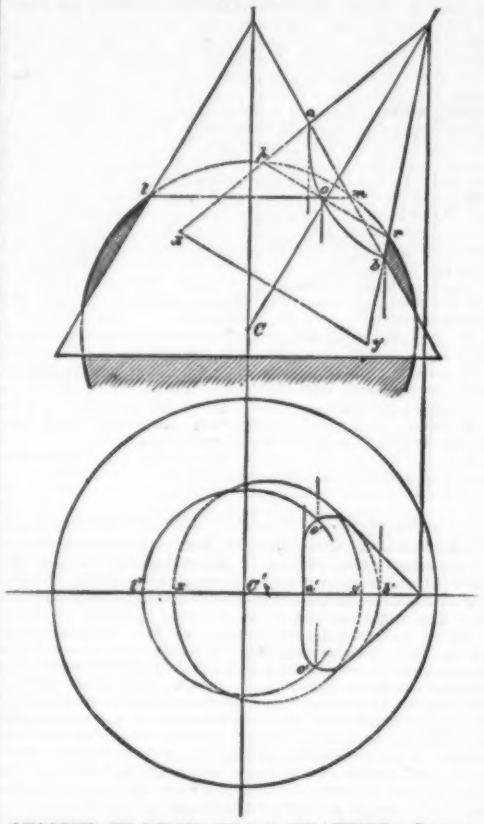
Fig. 50.

the paper in that view, in which those planes cut each other. That line is then a common chord of the two circles of intersection between the cones and the sphere, and *o* is a point in the intersection of the two cones. Projecting *o* to the circle through *l* in the top view, we have *o'*, *o'*, two points in the required curve as seen in that view, being in fact the two extremities of the common chord above mentioned. In like manner we may find any desired number of other points, and thus determine the curve with the degree of precision deemed advisable; it is hardly necessary to say that *a* and *b*, the highest and lowest points, are given at once by the intersections of the meridian outlines of the cones, which, as well as the axes, are parallel to the paper in the front view.

It is worthy of remark that the same sphere may serve to determine more than one point in the curve. Thus, in Fig. 52, the vertical cone is seen to intersect the sphere in the two circles *l m*, *n p;* the inclined cone intersects it in *r s*, which circle cuts both the others, giving the two points, *u* and *v*, of the required curve. We have given but this one view in this instance, and have also placed the cones in a very different relation to each other from that previously assumed, for the express purpose of furnishing the student with an exercise for him to work out for himself. The principles involved are perfectly general, and will apply under all conditions; but we must again caution the reader against the very common error of associating the solution of a problem with the appearance of a diagram, which may be totally changed by comparatively slight changes in the conditions; for the diagram is arranged solely for the purpose of illustration, while in actual practice the conditions are usually determined by circumstances wholly beyond our control. Those who have followed us through the previous series of lessons will recognize this as a thrice-told tale; but it will bear repetition, and there may be others to whom it may not appear so trite.

The methods above given will suffice for determining the curve of intersection of two cones whose axes cut each other, with all the precision required in a drawing intended merely to show the appearance of the solids thus penetrating each other. But that is not our only object in the present instance, as we are required also to develop the cones, in order to find the forms of templates by which to cut out the sheet

Fig. 51.



metal for such a can as is shown in Fig. 49. For this purpose another method of determining at least some points in the intersection will be found better than either of those above given; and the one which we are about to explain has this advantage also, that it does not matter whether the axes of the cone intersect or not. Nor, indeed, does it matter whether the bases of the cones are circular or not; in the ordinary use of the term, a cone is supposed to be circular, that is, such a figure as can be turned in the lathe; but the reader will have no difficulty in perceiving that if the base be an ellipse, for instance, instead of a circle, straight lines can still be drawn from every point of the curve to one point without, which would yet be properly called the *vertex* of the surface thus formed, which will be exactly the same as if we were to flatten a circular tin cone by pressing the sides together so as to make its transverse section an ellipse. The term cone then applies to any surface having rectilinear elements, all of which meet in a common point. Now, any two right lines which intersect determine a plane in which both lie; if, then, a plane passing through the vertex of a cone cuts the surface, it must cut it in right lines; if the reader's imagination fails him in forming a clear idea of this, the best aid is a material illustration, which he can readily make by taking a wooden cone, and planing it flat on one side, being careful to make the cut pass exactly through the vertex, as shown in Fig. 53, which we hope will render the experiment unnecessary. But, if not, he will find that in every case the planed surface will be bounded by two right lines meeting in the vertex. If this be true of one cone, it is true of two; so that, if the same plane passes through the vertices of both, we may have four right lines, two meeting in one vertex, two in the other, and, if these lines cut each other, the points of intersection must lie on both surfaces. This fact is wholly independent of the forms of the bases, as well as of the relative positions of the cones. And we can always pass a cutting plane through the two vertices; for, if we imagine a fine wire to be stretched from one to the other, it may be considered as an axis, about which a plane may turn, like a damper in a stovepipe, into any position desired, so that it will just touch either one cone or the other, cut both, or cut neither. This is illustrated in Fig. 54, in which the two cones whose vertices are *V, W*, are shown as standing on a horizontal plane, their axes being vertical. The line *BVW*, when prolonged, pierces this plane at *A;* and the three lines, *AB, AD, BD*, are evidently the three sides of a plane triangle. The line *AD* is the trace, or intersection, of this inclined plane with the horizontal plane on which the cones stand; it cuts the base of the nearer one in the points *m, n*, and that of the more remote in the points *o, r*. The points, *V, m, n*, all lie in the inclined plane, whence the lines *Vm*, *Vn*, also lie in it; but since *m* and *n* are points in the base of the cone, and *V* is the vertex, *Vm* and *Vn* must also be elements of its surface. Similarly, the plane *ABD* cuts from the further cone the elements *Wo*, *Wr*. If the cones were extended, by prolonging their elements, they would inter-

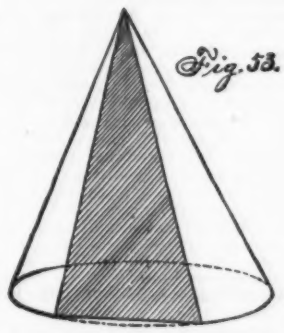


Fig. 53.

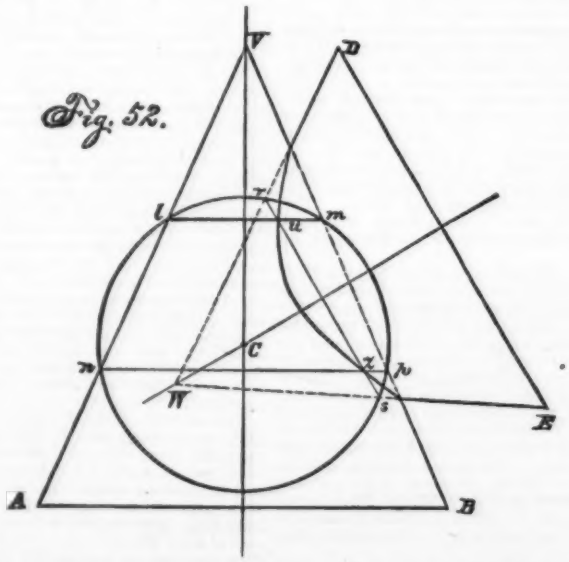
sect each other; and should *Vn*, *Wo*, for instance, meet when prolonged, the point of intersection would evidently lie on both surfaces. The cones are not shown as intersecting each other, because so doing would have confused the diagram, one object of which is to call attention to the use made of the point *A*, and of the line *AD*, in finding the elements which are cut from the two cones by the same plane. Since the cutting plane must always pass through *V* and *W*, it must also always pass through *A*, and so must its intersection with the horizontal plane, because *A* is situated in the latter. If, then, we draw any other line in the horizontal plane through *A*, as, for instance, *AC*, the points *g, e, k, l*, in which they cut the bases of the cones, will fix the positions of the elements cut from the surfaces by the plane *ABC*, of which *AC* is the trace.

And it is necessary to observe that this mode of operation is not at all dependent on the positions of the axes. We have shown them both vertical, for the sake of simplicity and convenience; but the reader will at once see that if one or both the cones had been cut off obliquely instead of "square across," all the difference due to that would have been in the forms of the bases, which would lie in the horizontal plane just as well if elliptical as if circular, nor would the process be at all affected if the axes should lie in different planes.

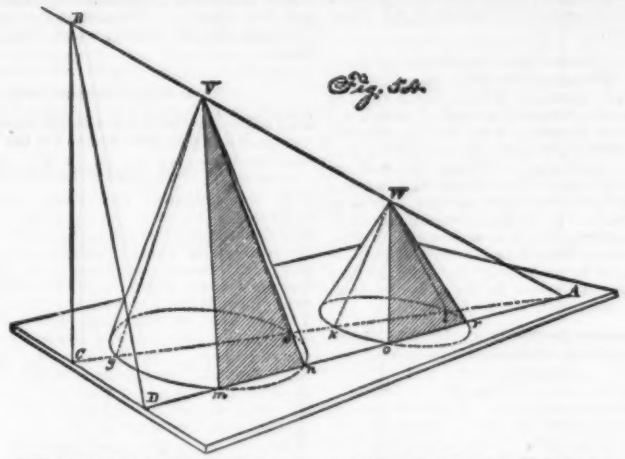
We now proceed to the application of the method just explained to the drawing of our oil-can, which is illustrated in Fig. 55. The first step is to draw the complete outline of the vertical cone forming the body. Then we determine upon the size and inclination of the smaller cone forming the lower part of the nozzle; the vertex of this being essential to further progress, the outline and axis of this cone are drawn in the side view, being prolonged from the vertex until the cone is cut by the horizontal plane, which is the base of the vertical cone. This plane cuts the small cone obliquely; the intersection is next to be constructed, which, having been previously discussed, all detail of this operation is omitted; the base thus found is the ellipse shown in dotted lines in the top view, where it is seen in its true form and size. Now joining the vertices *V, W*, by a right line, produce that line until it pierces the horizontal plane at *A;* since the axes in this case intersect and are parallel to the paper in the side view, this point will in the top view appear at *A'* in the horizontal center line.

From *A'* draw any line as *A'D*, cutting the circular base of the large cone in *m', n'*, and the elliptical base of the small one in *o', r'*. *V'm', V'n'*, will be the horizontal projections

Fig. 52.



of the two elements cut from the vertical cone; but it is evident that we shall have nothing to do with the latter, since the small cone is not to pass entirely through the large one; we therefore project m' vertically upward to m, and Vm is the side view of the former element. Now draw $o'W'$, $r'W'$; they are the two elements cut from the inclined cone, as seen in the top view, where they cut $V'm'$ in the points u', s', which may be projected up to Vm, where they will appear as u, s, two points in the side view of our required curve. Or, should the intersections in this case be too acute to be reliable, we may project o', r', up to o, r, and drawing Wo, Wr, we have the side view of these two elements, which will cut Vm also in the points u, s. This process may be repeated as many



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times as is deemed requisite, and the curve thus fully determined.

If now we draw a line $A'E$ *tangent* to the elliptical base of the inclined cone, and determine the point of tangency p (the manner of doing which was explained in Lesson XXIV. of the first series), it is clear that the plane of which it is the trace will not *cut* the cone, but will be tangent to it all along the element $p'W'$, which in the side view appears as pW. This plane, however, will cut the larger cone, and the element $s'V'$, sV, thus found, intersects pW in the point x', x. This element, sV, then, limits the curve of intersection, and is tangent to it; a circumstance which is of some interest and value in relation to the development.

The spout of the can is formed of two pieces, and the mode of thus making an angle without changing the taper of the tube is illustrated in Fig. 56. Let the cone whose vertex is V be cut by the plane $a\,b$; the section is an ellipse whose center is c, the middle of $a\,b$, and if we suppose a pin fired at c, perpendicular to the plane, as $e\,g$, it will be seen that the top of the cone may be turned around this pin, until the axis of the ellipse is reversed, when the vertex will be at U, Ub being equal to Va, and Ua to Vb; the axis will be Ug the angles $Ue\,a$, $Vd\,b$, being equal.

Thus the second joint of the nozzle in Fig. 55 is in reality merely a part of the upper end of the cone forming the first joint; the small dimensions in that figure rendering it necessary to introduce a second diagram for the purpose of illustrating this relation of the two parts, although we have drawn the nozzle rather too large to be in good proportion as it is, since otherwise the operations we have been describing could not have been clearly shown without occupying too much space. This, however, is rather an advantage than a disadvantage, inasmuch as the reader will or should be desirous of constructing his drawing upon a practical basis, and thus, selecting better proportions, he will be under the necessity of varying the conditions, and will find it impossible to copy.

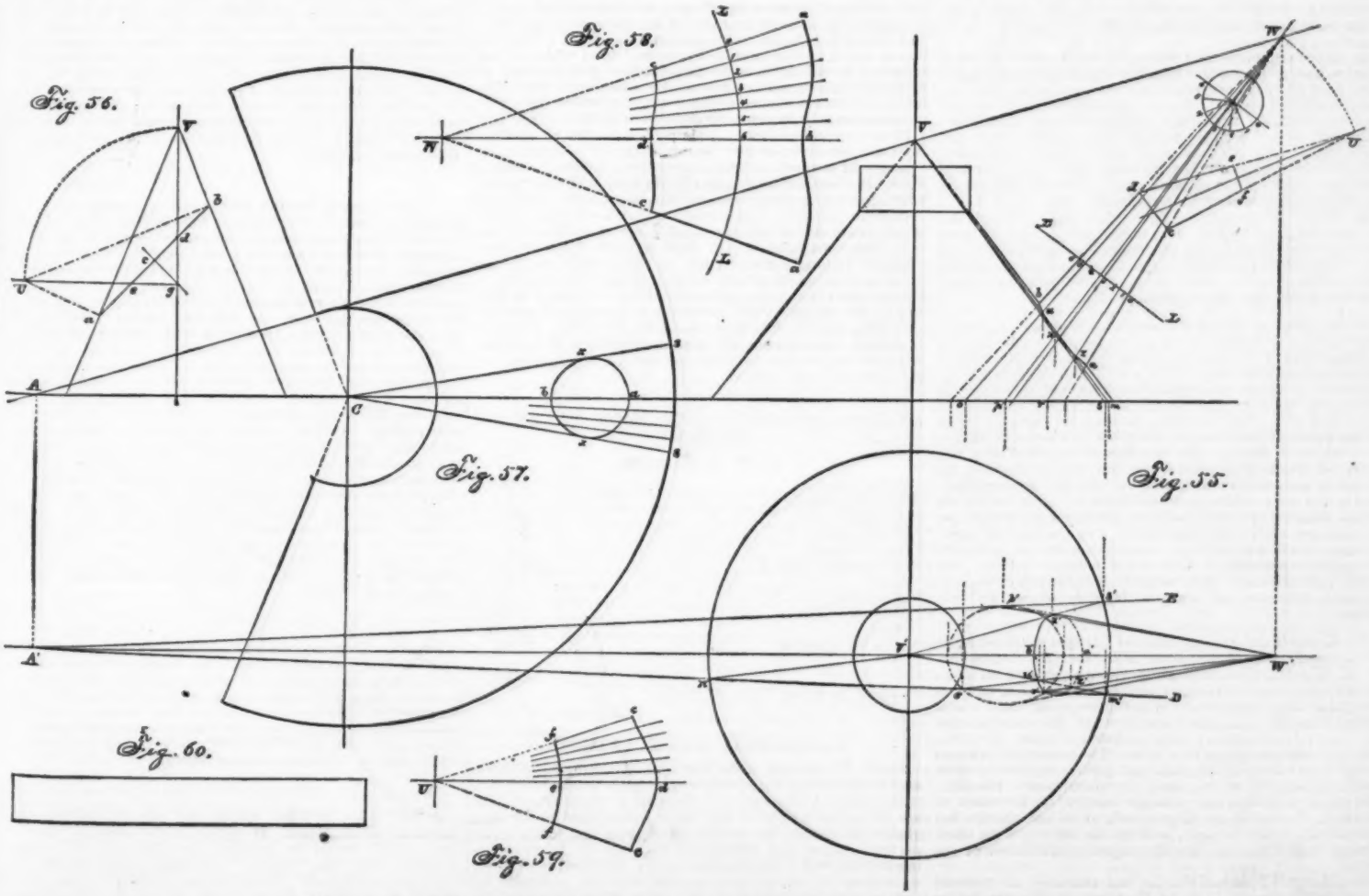
We have thus completed all the difficult part of the construction, as the tip of the nozzle is cut off perpendicularly to the axis of the cone, and so is the top of the can, a plain cylindrical ring or band being added for the reception of the cover, which is merely a similar band with a circular end. Now it remains to develop the different pieces, in which lies the practical utility of what has preceded, for, without first determining these curves of intersection, it would be impossible to find the forms of the sheet metal of which the parts are supposed to be made.

Beginning with the larger cone, we first observe the advantage of the third method of finding the intersection, above alluded to in speaking of the limiting or tangent lines. For these tangent elements at once give the whole arc to be rectified and subsequently measured off on the development, Fig. 57, thus determining Cs, Cs, which will include and be tangent to the curve now sought, the points of tangency, x, x, being fixed by measuring from C, distances equal to the actual length of Vx. It will now also be seen that the process of development will be much facilitated, if a systematic course be adopted in constructing the intersection. In describing that operation, no special order was observed, nor is it *necessary* that any should actually be observed; but it will now be seen that it would be very convenient to know the positions of points located on elements dividing the angle $s\,C\,s$ into equal parts. For if we do not know them, but must make use of those selected at random, as in the explanation above referred to, we shall be obliged to repeat again and again the operations of rectifying the unequal fractional arcs, and finding singly the positions of various elements in the development.

Consequently, it will be advisable in practice to proceed thus; draw first the two tangents to the elliptical base of the inclined cone (of which $A'E$ is one), and subdivide the arc of the circular base of the vertical cone, intercepted by them, into equal parts; then draw lines to A' through the points of subdivision, for the traces of the cutting planes, by which to find points in the curve of intersection. The points thus found lying on equidistant elements of the upright cone, we have only to subdivide the arc $s\,s$ into the same number of equal parts, and locate the points on the radii through the points of subdivision. This serves to illustrate the advantage of a careful study of a problem in all its bearings before beginning the execution; it will very often be found that time thus spent will be more than saved before the work in hand is finished.

We have next to develop the first or lower joint of the nozzle of the can. This is a part of a circular cone, but it is cut off obliquely at the upper and irregularly at the lower end, in the one case by a plane, in the other by the larger cone. These terminations, therefore, cannot be developed directly; but since the vertex remains a point, in the development, it is only necessary to find some curve cutting all the elements, whose development we can predict, in order to gain our end. This is done by cutting the cone perpendicularly to the axis by any plane, as LL; this section is a circle, which again develops into another circle, as usual, thus enabling us to ascertain the positions of the elements on the plane. This done, we have only to set off from the vertex the actual distance measured on the original elements to the upper and lower curves of intersection, in order to locate points in their developments. It is to be observed here that the equidistant elements of the larger cone, above mentioned, will not intersect equidistant elements of the smaller one; yet it will be as convenient here as in the previous case to have the elements uniformly spaced in the development. We must, then, subdivide the circle cut from the cone by the plane LL into equal parts, and projecting the points of subdivision back to LL, as at 1, 2, 3, etc., draw a new set of elements through these points, cutting the curves of intersection, already determined, in points which we may then use in finding the developments of those curves. The figures, 57–60, are the developments of the body, the first and second joints of the nozzle, and the cylindrical neck of the can, in the order named. The two joints of the nozzle are cut along the lower side, the seam being $a\,e\,f$ of Fig. 55; the corresponding letters in this figure, and the developments, will enable the reader to trace the processes above described, without further assistance.

SCIENCE is ever improving the delicacy of her means of investigation, and so is enabled to throw fresh light from time to time on familiar natural phenomena. The discharge of the Torpedo has lately been studied anew by M. Marey, who applies to this his graphic method, and uses M. Lippmann's very delicate electrometer and M. Despré's inscribing apparatus. The experiments show that, if you excite a nerve of the electric apparatus, there is a flow of electricity following about 1-80th of a second on the excitation. It lasts 1-40th of a second. In the uninjured animal the voluntary discharges are composed of a series of successive flows of currents, which, according to the temperature, vary from 20 to 140 shocks in a second. The electrometer shows that the direction of the current is from the back to the belly of the animal. The currents of the torpedo generate, in an induction coil, inverse currents, arising at the commencement of each of the flows of a discharge. In the fish, as each of the flows lasts about ten times longer than the interval separating them from each other, an addition of these flows takes place, which gradually increases the intensity of the discharge. All these phenomena correspond closely with what is observed in the production of muscular work.



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES, No. 8.

CHEMICAL SOCIETY, LONDON.

DR. J. H. GILBERT, Vice-President, in the chair.

On the Estimation of Urea by means of Hypobromite, by Dr. A. Dupré. The object of the communication being to describe a form of apparatus which could be conveniently worked, and such modifications in the preparation of the hypobromite solution as to prevent the escape of any bromine vapor, so that the process might be used in the wards of an hospital. The apparatus consists of a burette immersed in a tall cylinder of water and connected by a side tube with the generator by means of a long piece of caoutchouc tube. The generator containing the proper quantity of hypobromite is a bottle closed by a vulcanized cork, through which passes a short tube to connect it with the burette, and also having a small test tube attached to it to contain 5 c.c. of the urine under examination; after the cork has been firmly inserted, the urine is mixed with the hypobromite by gently inclining the generator. The latter is briskly agitated for a short time and then plunged into cold water. After allowing the apparatus to stand a few minutes to cool the gas to the same temperature as the water, the level of the liquid inside and outside the burette is made the same by raising the latter, and the reading of the gas taken and also the thermometer. The necessary quantity of hypobromite is easily prepared by pouring into a stoppered cylinder enough caustic soda solution, 100 grammes to 250 c.c. of water, to fill it up to a 25 c.c. mark on the side, introducing a thin sealed tube containing 2·2 c.c. of bromine, and agitating briskly so as to break the thin tube. The amount of nitrogen given off is found to be 91 per cent. of the total quantity in the urea, and the burette may be so graduated that it gives readings of the percentage of urea at the normal pressure and temperature.

The Chairman said they were much indebted to the author for facilitating the process for the estimation of urea, one of the most important in hospital practice, as showing the amount of nitrogen eliminated by the renal organs. Although urea represents nearly all the nitrogen in the urine of the human subject, this was not the case with the ruminants.

Dr. C. R. A. Wright remarked that in some experiments on this method of determining urea made in his laboratory by Dr. Blackley, a slightly higher percentage of nitrogen had been obtained—about 93 per cent. The apparatus described by Dr. Dupré possessed considerable advantages over those of Russell and West, and of Dr. Blackley, as there was no danger of spilling the corrosive hypobromite solution if ordinary care were taken; at the same time, in agitating the generator, the latter might get heated and thus increase the reading.

Professor Hartley suggested the substitution of a gutta-percha tube for holding the urine in the generator in place of the fragile glass one.

A new Carbometer for the Estimation of Carbonic Anhydride, by Mr. S. T. Pruen and Dr. G. Jones. It is somewhat similar to Scheibler's calcimeter, consisting of two equal graduated glass tubes filled with water, on the surface of which a layer of oil floats, and connected with each other by a piece of caoutchouc tubing. One of these is raised or lowered automatically, the other is fixed, and connected at its upper extremity with the generator by means of india rubber tubing, a chloride of calcium tube being interposed between the generator and the measuring tube. The generator consists of a small flask in which a weighed quantity of the carbonate under examination is placed, together with a small gutta-percha tube containing hydrochloric acid. The decomposition is effected in the usual way, and the evolved gas measured; the barometric pressure being taken and the temperature observed by means of a thermometer in the measuring tube. Tables of date for the necessary corrections accompany the paper. The authors state that it is more convenient than Scheibler's apparatus, as it is less cumbersome, the tubes do not require refilling or emptying, and it is self-acting.

Mr. Warrington observed that there was a source of error in the Scheibler instrument when also attached to this apparatus, namely, that the correction to be applied for the carbonic anhydride dissolved by the hydrochloric acid was the same whatever the percentage of the carbonic anhydride; whereas, if there was much air and comparatively little carbonic anhydride in the flask at the close of the experiment, the hydrochloric acid would absorb but little of the carbonic anhydride, whilst if the air were rich in carbonic anhydride the acid would absorb more of the latter.

Dr. Dupré called attention to the fact, that, although the gas was dried by passing over the calcic chloride, it must become wet by contact with the moist sides of the measuring tube; to which Dr. Jones replied that it was found practically that the film of oil prevented the gas from coming in contact with the water, and thus becoming moist.

On the Influence exerted by Ammonium Sulphide in preventing the Action of various Solutions on Copper, by Messrs. F. W. Shaw and T. Carnelley. Clean pieces of copper foil of known surface were coated with a thin film of sulphide by immersion in dilute ammonium sulphide, and subsequently thoroughly washed. The result of the action of distilled water and of various solutions on these as compared with similar pieces of clean copper are given in a series of tables, from which it appears that the film of sulphide does not lessen the action of distilled water, but, on the contrary, increases it, both at the ordinary and at elevated temperatures. This is due to the oxidizing action of the air, as shown by the results obtained in closed flasks completely filled with water that had previously been well boiled. In the case of saline solutions, the film of sulphide lessens the action on the metal, the salts experimented with being potassic nitrate, sulphate, and carbonate; sodic chloride, nitrate, and carbonate; magnesic sulphate; and ammonic chloride, nitrate, and sulphate.

An Experimental Inquiry as to the Changes which occur in the Composition of Waters from Wells near the Sea, by Mr. W. H. Watson. The well examined was about 9 ft. deep, the bottom being 24 ft. above the level of the sea, and was situated at Braystones, near Whitehaven, about half a mile distant from the sea. Determinations of the chlorine were made each day, the water being collected at about 10 A.M., and the results are given in a table. The amount of chlorine varied from 5·95 to 17·50 grains per gallon, whilst the other constituents, such as sulphates, remained almost constant. The author considers the variation observed in the water of this well, situated in an alluvial soil, to be due chiefly, but not entirely, to the weather, as from the nature of the intervening strata it may be directly subject to infiltration of sea water.

Mr. Maxwell Lyte said that he had examined the mineral waters of the Source de Salut Bagnieres de Bigorre during many years, and had found that from October to December an extraordinary change took place in the nature of the water, as it became sulphurous, and the quantity of salt in it increased. It was probable that the deep spring was sulphurous, but became altered by the infiltration of other springs near the surface, which, after the droughts of summer, partially dried up; thus the supply of oxygen being partially cut off, the spring resumed its sulphurous character.

Mr. C. E. Groves remarked that springs in alluvial soils near the sea might derive much of their chlorine from the scud driven over the land in stormy weather, and which, settling on the land, was washed in along with the surface water by subsequent rains.

The Chairman, in thanking the author, said it was necessary to know all the circumstances connected with the well before the source of the large amount of chlorides in it could be definitely accounted for.

On the Solvent Action of various Saline Solutions on Lead, by Mr. M. M. P. Muir. The author, from an examination of the action of various saline solutions on lead, infers that, in the first place, a soluble salt of lead is produced, which, by the action of carbon dioxide absorbed from the atmosphere, is slowly converted into hydrocarbonate, in which form it is to a greater or less degree precipitated. In certain solutions, especially those containing ammonium nitrate and calcium chloride, the formation of the soluble lead salt proceeds more rapidly than its precipitation as hydrocarbonate, although after long periods the latter action preponderates. Lastly, corbonates reprecipitate the soluble lead salt in the form of hydrocarbonate as fast as it is produced. A table showing the solubility of lead hydrocarbonate in the saline solutions examined is appended to the paper.

The Derivations of Di-isobutyl, by Mr. W. Carleton-Williams. The di-isobutyl employed in the investigation was prepared by the action of sodium on isobutyl bromide and boiled at 100° C. Submitted to the action of chlorine, it yielded a liquid possessing an odor resembling that of the orange, and consisting of a mixture of iso-primary and iso-secondary octylic chlorides, boiling at 170° to 180°. The mixed chlorides, heated with potassic acetate, an acetic acid, at 200° yielded, besides the octylic acetates, an octylene boiling at 122°, and which had a specific gravity of 0·7526 at 16°. The mixed acetates boiled at 196° to 205°, and by treatment with potassic hydrate were converted into a mixture of the primary and secondary octylic alcohols, boiling at 175° to 187°, the quantity of which was too small to permit of any attempt at separation. It was, therefore, oxidized by potassium dichromate and sulphuric acid, when it yielded iso-caprylic acid, and an acetone, which on further oxidation split up into acetic and carbonic acids. From these results it would seem that the secondary alcohol is isopropyl isobutyl carbinol

$$CH(CH_3)_2.CH(OH).CH_2.C(CH_3)_3,$$

whilst the primary alcohol may be represented by the formula

$$CH(CH_3)_2.CH_2.CH_2.CH(CH_3).CH_2(CH)$$

The isocaprylic acid is an oily liquid, somewhat resembling valerianic acid in odor. Its silver salt is slightly soluble in boiling water, and is deposited, on cooling, in minute tooth-shaped crystals. The barium lead and zinc salts are amorphous, but the calcium salt is characteristic, crystallizing in plates radiating from a central point. It is less soluble in hot than in cold water, so that on raising the temperature of a solution saturated at 15° to 36° C. the salt is precipitated.

Notes on Madder Coloring Matters, by Dr. E. Schunck and Dr H. Roemer. The first of these describes the method of detecting small quantities of alizarin in mixtures of alizarin and purpurin, by exposing the solution of the substance in caustic alkali to the air until it has become almost colorless; the purpurin is thus decomposed, and on agitating the acidified solution with ether the alizarin is taken up and may be recognized in its usual manner by its absorption spectrum. The second note is on "Purpuroxanthic Acid, a Coloring Matter found in Commercial Purpurin," from which it was separated by boiling it with alum liquor, precipitating by hydrochloric acid, and extracting the precipitate with alcohol; a residue containing alumina was left, which gave purpuroxanthic acid by crystallization from alcohol mixed with a little hydrochloric acid. This acid may also be obtained from the alcoholic mother liquors obtained in crystallizing commercial purpurin by evaporating them, boiling the residue with water, and adding hydrochloric acid with the filtrate, which throws down the impure purpuroxanthic acid as an orange precipitate. It is purified by boiling it with baryta, which dissolves the impurities and leaves the acid as a basic salt. Purpuroxanthic acid, $C_{13}H_8O_6$ or $C_{14}H_7O_5COOH$, crystallize in yellow lustrous yellow needles or scales which are easily soluble in alcohol and acetic acid; and far more so in boiling water than most madder products. It melts at 231° and at 232° to 233° Cent. decomposes, giving off carbonic anhydride and leaving purpuroxanthin, $C_{14}H_8O_4$ no other substance being produced. Purpuroxanthic acid dyes alumina and iron mordants orange and brown respectively, but the colors are very fugitive.

ANALYSIS OF CHINA CLAYS FROM KIN-KIANG, IN CHINA.

By M. W. KALMANN.

Silica (soluble)	0·501
Silica (insoluble)	50·133
Alumina	32·737
Ferric oxide	0·955
Ferrous oxide	1·690
Manganous oxide	0·827
Lime	0·501
Magnesia	0·268
Potassa	2·520
Soda	traces
Loss on ignition	10·011
	100·146

—*Bull. de la Soc. Chim. de Paris.*

LABORATORY MANIPULATIONS.

DR. P. T. AUSTEN, of the New York Academy of Sciences, says the following apparently unimportant details often contribute much to the ease and pleasure of working:—1. The use of square pieces of felt, such as are used under beer glasses in saloons, for setting hot beakers and flasks on to prevent chilling and consequent cracking. 2. In crystallizing substances for examination under the microscope; one watchglass is placed upon another with the substance between them, and the upper glass filled with ether, the cold produced by its evaporation hastening the crystallization. 3. Removing precipitates and solid matter from flasks by heating to boiling, and inverting in a vessel of water. 4. Crystallization by gradual dilution. 5. Filter water without ash. In German laboratories it is customary to dissolve out the mineral matter from white filtering paper by washing in dilute hydrochloric and hydrofluoric acids. 6. The use of infusorial silica for drying purposes. Being very porous, it will absorb five times it own volume of water. If a filter paper, holding a wet precipitate, be placed upon a layer of this earth, it will become quite dry in a very short space of time. Mr. Austen also remarked that substances retained their heat for several days when placed in cork boxes. To keep a substance air-tight, it may be placed in a flask, the neck painted with a solution of india rubber in chloroform, and a plate of glass laid upon it. The solvent quickly evaporates, leaving a delicate film of rubber, which holds the glass tightly in place.

[BULLETIN DE LA SOCIETE CHIMIQUE DE PARIS]

DETERMINATION OF PHOSPHORUS AND ARSENIC BY THE MOLYBDATE OF AMMONIA.

By MM. CHAMPION AND H. PELLET.

M. BOUSSINGAULT has shown that the approximation furnished by directly weighing the phospho-molybdate is superior to that obtained by redissolving the precipitate and determining the phosphorus as ammoniaco-magnesian phosphate. The error committed is the more appreciable the less phosphorus is present in the matter under analysis. According to M. Boussingault, the phospho-molybdate contains 3·73 per cent. of phosphoric acid. The operation may be performed very rapidly by observing the following precautions: Dissolve 100 grms. molybdic acid in ammonia (about 150 c.c. of ordinary ammonia) and 80 of water. Pour it drop by drop into 500 c.c. of pure nitric acid and 300 c.c. of water. Stir, let settle, and filter if needful. Introduce into a capsule such a measure of the molybdic solution that the weight of the molybdic acid may be about fifty times the supposed weight of the phosphoric acid. Add ammonia to render the liquid alkaline; concentrate as far as possible the liquid containing the phosphoric acid, and mix the two solutions; raise the temperature to 70° to 80°, and pour in rapidly an excess of nitric acid until the yellow coloration appears, stirring briskly to aid the formation of the precipitate. Filter through a double tared filter, wash, and dry at 100° to 110°. The filtrate should be colorless. If it is yellow the precipitation is incomplete; in this case ammonia is poured upon the filter to redissolve the precipitate, the solution is evaporated, and reacidified with nitric acid. The same process may be successfully applied to the determination of arsenic, 100 grms. of the precipitate of arseniomolybdate of ammonia containing 5·1 of arsenic acid.

SULPHUR OF GYPSUM AND OF SODA EMPLOYED IN THE GLASS MANUFACTURE.

By M. O. SCHOTT (DINGLER).

THE author forms a double silicate of lime and soda by heating together silica, sulphate of soda, and gypsum with the quantity of carbon necessary to reduce these salts. Complete fusion of the mixture is not needed. The sulphurous acid evolved may be passed at once into the lead chambers. The double silicate produced—which the author calls *crude glass*—serves for the manufacture of glass by fusion along with silica, soda, or lime, according to the nature of the glass to be produced. The proportions for the crude glass itself may be modified as deemed requisite. One of the objections made by glass manufacturers is that the escape of gas during vitrification is necessary to render the mass homogeneous. But as each kilo. of the mass to be vitrified gives off 1 litre of gas, this quantity is much more than sufficient. A certain quantity of unreduced mixture may be added to complete the vitrification of the "crude glass." In the reduction of the sulphates we may substitute for carbon a sulphide such as soda-waste; the sulphurous acid escaping is then free from carbonic oxide, and its transformation into sulphuric acid in the chambers is effected with more regularity.

A NEW VELVET-DYEING MACHINE.—A correspondent of the *Frankfurter Zeitung* writes as follows from Frankenthal: "An important improvement is likely to ensue in the manufacture of velvet from the recent patented velvet-dyeing machine of Messrs Albert & Co., Schnell-pressenfabrik, Frankenthal. Velvet has up to now been dyed by hand or manual labor, an experienced hand being able to dye some 60 yards per day. By the present machine, however, at least 600 yards may be dyed per day, the mixing and distributing of the dye-color being much more uniform; besides, one man can attend simultaneously to four of these machines, hence can dye 2,500 yards of velvet per day, better than has hitherto been possible. We have seen the construction of this very ingenious machine, and find that, by the cheaper manufacture of dyed velvets, an important progress has been made in the manufacture of German velvets, which will render the latter better able to compete in the world's commercial markets. We understand that the inventors of this machine intend to construct several of these velvet-dyeing machines as soon as they have completed the extension of their works, unless some favorable opportunity presents itself in the meantime to sell the patent right. Of course, the eventual importance of this invention confines itself to cotton-velvets or velveteens, inasmuch as silk-velvets cannot be dyed in the piece."

PRINTING PHOTOGRAPHS ON GLASS.—M. Siegwart, in the *Polytechnisches Journal*, directs the operator first of all to secure an image by means of gum, honey, etc., and bichromate of potash, and to dust this hygroscopic picture with red lead powder. The red lead image is then burnt in; and the more soluble lead glass thus obtained is treated with concentrated nitric acid, whereby a dull, white image is produced which may be viewed as a transparency.

A NEW color is being offered for sale in Europe as a substitute for cochineal. It rejoices in the name of "Nopaline," which would be justifiable only in case of a color prepared from the "Nopal," the plant upon which the cochineal insect feeds. Some samples, on examination, have proved to be eosine, whilst others are merely preparations of cochineal.

CATECHU DE LAVAL, A NEW COLORING MATTER FOR LINEN AND COTTON.

THIS name has been given by MM. Croissant and Bretonnière to the sulphuretted organic coloring matters which they discovered some years ago. Though these products have no analogy with catechu they give certain catechu shades. The color produced upon cotton is modified according to the method of fixation employed. The fixation is effected either with an acid (sulphuric or muriatic), with sulphate of copper, or iron, and especially with bichromate of potash. Catechu de Laval is characterized by its affinity for vegetable fibers, and by its power of serving as a mordant for a number of colors which are not capable of dyeing cotton directly, such as the aniline colors, the extracts of the woods, etc. To dye cotton, from ½ to 2 kilos. of the color are dissolved in ten times its weight of boiling water, as pure as possible (especially free from lime) to 10 kilos. of cotton. As the solutions are unstable, they must only be prepared as wanted. This solution is gradually strained into 100 litres of water at 60°. At the end of the dyeing, bisulphite of soda is added to the bath in the proportion of 75 to 100 grms. per every 100 grms. of color. The dyeing lasts from twenty to twenty five minutes. The cotton is then washed, and passed into a hot beck of 300 grms. bichromate or of another fixing agent (sulphate of copper or iron) 200 grms. sulphuric acid, or 500 grms muriatic acid After a few minutes the cotton is taken out and dried. To obtain compound colors, the cotton dyed as above, and well washed, is passed into baths of magenta, extracts of woods, etc. Catechu de Laval may be used for dying jute, linen, etc. It must be preserved from damp.

CELLULOID.

THIS substance is a modified form of gun cotton, forming when dried a horny elastic substance. In its wet state, zinc-white and other coloring matters are added, and it is pressed into various shapes. It is highly inflammable. We showed some time ago how easily harness rings of celluloid could be set on fire. Two new cases are reported in Chicago.

During a game of pool one of the balls dropped off the table, and coming in contact with a lighted cigar stump on the floor, the ball instantly caught fire and blazed, with a slightly sputtering noise, until its outside coating was consumed.

Examination of the ball, after the fire, showed it to be made of a solid globe of compressed cotton, covered with white composition about ½ inch thick; this composition, resembling ivory, was probably celluloid; but whether this is so or not, it is certain the incendiary composition is extensively used in manufacturing the cheaper quality of billiard and pool balls.

Subsequently, during a game of pool in another saloon, a player holding a lighted cigar in his hand, picked up a ball, which, coming in contact with the cigar, instantly blazed with the same hissing noise as before described; the barkeeper had sufficient presence of mind to throw his coat over the villainous compound, and succeeded in preventing further damage than the burning of the outer coating of the ball and severely scorching his fingers.

NEW COMBUSTIBLE.

A NEW French combustible compound has a base of carbonized tan or wood bark, and this is mixed with a small quantity of nitrate of lead or spirits of nitre; slaked lime or loam being added as agglutinative matter. It ignites easily, burns gradually and continuously in this state, and still slower by adding a small quantity of wood charcoal-dust. Neither smoke nor odor is perceptible. A small quantity burned in a foot-warmer or chafing-pan, with a limited supply of air, will not be entirely consumed for about sixteen hours, and during that time will develop heat enough to warm a compartment of an ordinary carriage. The dangerous railroad stove may be succeeded by an improvement on some such mode of heating as this. It may be that steam pipes, supplied with either live or exhausted steam, and connected by flexible gutta percha pipes, might be much better; but it is certain that some general provision of safety from this source of danger to life and property is needed. Pipes for heating have been introduced into all the passenger railway cars of Alsace and Lorraine. The heat can be regulated for each compartment.

A NEW series of dye stuffs, formed by the action of glycerine on phenol—carbolic acid—in the presence of sulphuric acid, has very recently been discovered by Reichl, of Prague, who is still at work on it. Both red and purple have been obtained in this way. He has also obtained dye stuffs by the action of glycerine on pyrogalic acid and on thymol, and purposes to study its action on cresol and other phenols. This opens a new field for study. W. H. Perkin, the discoverer of the first aniline dye, is still finding new things in the color line. Among his recent papers is one on anthrapurpurin. Lauth has succeeded in preparing a new class of dyes by the introduction of sulphur into aromatic diamines, and then oxidizing the sulphur compound. It forms a beautiful purple. A natural dye stuff capable of forming lakes has been obtained by Mederstadt from the *musa fehii*, a plant of the banana family. Aniline black has attracted more attention than any other aniline color. Most of the experiments relate to the use of vanadium, which has almost entirely superseded copper, notwithstanding its price. One part only of vanadium salt is required for 50,000 parts of aniline oil.

PAINLESS EXTINCTION OF ANIMAL LIFE.

"THE latest experimental researches which I have conducted on lower living animals," says Dr. B. W. Richardson, "have had for their object the discovery of a ready, cheap, and innocuous method for killing without pain those animals which are destined, as yet, for the food of man. If the labor of the physiologist be allowed to progress, the day will soon arrive when the slaughter of animals for food will become unnecessary, since he will be able to so transmute the vegetable world as to produce the most perfect and delicious foods for all the purposes of life without calling upon the lower animal world to perform the intermediate chemical changes. But, until this time arrives, animals will have to be slaughtered, and my research has been directed to make a process, which at present is barbarous and painful, painless in the most perfect degree. For this purpose the various modes of rapid destruction of life—by powerful electrical discharges, by rapid division of the *medulla oblongata* and by the inhalation of various narcotic vapors—have been carried out. The experiments, which have been exceedingly numerous, have led me to the conclusion that the most perfect of the painless methods of killing is by the inhalation of carbonic oxide gas. So rapid and complete is the action of this gas, that I may say physiological science has done her part, as far as it need be done, for making the painless killing of every animal a certain and ready accomplishment, an accomplishment also so simple, that the animal going to its fate has merely to be passed through the lethal chamber, in order to be brought in senseless sleep into the hands of the slaughterer. The application of teaching and the putting into practice this humane process lies now with the world outside science; but to insure its acceptance, all the force of selfishness, of prejudice, and of practical apathy for the sufferings of the animal creation, have to be overcome There is a great deal of talk and a great deal of sentiment abroad on the question of the sufferings of the lower animal kingdom, but when an attempt is made to relieve those sufferings by the invention of methods for operating, surgically, without the infliction of pain, or for painless killing, the true and vital sympathy which one would expect in support of such practical and humane efforts, until they are made perfect and universal, can scarcely be said to be found at all. With the exception of a few, not a dozen altogether, of really humane ladies and gentlemen, I have found no one, out of the ranks of science, in the least interested in the saving of sufferings to which I am now directing attention. The man of science stands and wonders at the strangeness of the psychological problem before him; and, in spite of himself, is forced to the conclusion that, practically, the noise that is made at him in the name of humanity is, after all, sounding brass and tinkling cymbal.—*Nature.*

LITHOTRITY WITH NITRIC ACID.

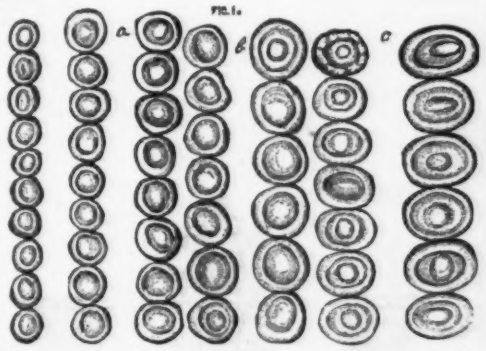
IN March, 1875, a police officer, aged 45, was admitted into the Liverpool Royal Infirmary, under the care of Mr. Harrison. Upon examination, a single stone was found in the bladder; it was rounded and had a diameter of two inches and a quarter. The urine was alkaline and contained pus. After some preliminary treatment, lithotrity was performed on April 5th, and the crushings were repeated twelve times during April and May. The patient never experienced any unfavorable symptoms, and a good deal of broken-up stone was passed, but as it seemed that fresh phosphatic depositions were taking place almost as fast as the others were removed, Mr. Richardson resolved to use nitric acid injections. On May 27th (two days after a crushing), he had all the urine passed during 24 hours collected and examined. Its quantity was 60 ounces, and it contained 74·029 grains of phosphoric acid in the form of alkaline earthy phosphates, and 250·516 grains of phosphoric acid in the form of alkaline phosphates. He then injected into the bladder half a pint of tepid water with two drachms of dilute nitric acid. During the next 24 hours 78 ounces of urine were passed, which were found to contain 96·237 grains of phosphoric acid as alkaline earthy phosphates, and 461·94 grains of phosphoric acid as alkaline phosphates. Hence, after the nitric acid treatment, the percentage of alkaline earthy phosphates in the urine was slightly increased, while that of the alkaline phosphates was very considerably increased. The absolute increase of the phosphates was, however, much more marked. On nine subsequent occasions the lithotrite was employed, and on every second or third day afterwards the bladder was injected as before with tepid water and nitric acid. The alkaline phosphates were increased after each injection, and it was also noticed that the fragments passed were more finely triturated than previously. The patient left the infirmary cured on June 21st. The total quantity of broken-up stone collected weighed four drachms. Mr. Richardson thought that the acid stopped at once any further deposition of phosphates, and facilitated the removal of the broken fragments.—*British Medical Journal.*

[Continued from page 1060. SUPPLEMENT No. 68.]

CONTRACTION OF BLOOD CORPUSCLES THROUGH THE ACTION OF COLD.

In another experiment corpuscles of ox blood, carried to zero, measured $\frac{1}{3\,3\,5\,5}$ of an inch. The blood which had been frozen and afterward allowed to reach 80° Fahr., before being put upon the slide, did not show any expansion of the disks.

FIG. 1.



I give drawings of the comparative size of the ox and calf's blood corpuscles, as seen at their normal state, and after exposure to the two successive stages of cold from freezing to zero (Fig. 1). To this I have added drawings of the comparative size of human blood from one individual at its normal state, and also after exposure to cold as low as zero. These corpuscles are taken from tables containing a large number, and cannot be far from the true measurement. The other tables, which I have made from a number of individuals, under the same conditions as those described above, agree as closely in the result as is the case with the *normal* tables made from blood-disks obtained from the same individuals I give also drawings of hen's blood, both in the normal state and after exposure to the freezing mixture.

Fig. 1 *a* shows three columns of drawings of ox-blood disks—the largest is of the normal size; the next smaller shows the corpuscles as found after being taken from the icehouse; the third after exposure to the freezing mixture. The columns contain eight, nine, and ten corpuscles respectively.

Fig. 1 *b* exhibits two columns of human blood disks, the first seven in their normal condition, the second six as seen after exposure to the freezing mixture.

Fig. 1 *c* represents two columns of hen's blood under like conditions as the preceding. It will be seen by this formula that, if one hundred corpuscles of ox-blood which have been exposed to cold be placed in a square, they will occupy the space of sixty-four normal ones, showing a loss of about a third of their superficial area. A table of forty-nine human corpuscles of blood, under like circumstances, will occupy the space of thirty-six normal ones, showing a loss of about one-fourth of their area. And the same may be said of the hen's blood. In these experiments I have drawn and placed in tables fifteen hundred corpuscles of blood from nine individuals; this, I think, may be deemed sufficient to settle the fact of shrinkage in all cases of blood-corpuscles upon exposure to cold, when separated from the living system; still, I should not consider this conclusive as to the percentage of shrinkage in every case, especially as important legal questions might be involved in the decision.

I give a drawing showing the appearance on the slides of the ox-blood which has been exposed to cold. The magnifying power in this case was eight hundred diameters.

In addition to the experiments described above, I have

made six tables of forty-nine corpuscles, each from hospital patients, which sum up as follows: No. 1, normal measurement, $\frac{1}{3\,3\,5\,5}$ of an inch; after exposure to a temperature of zero of F., $\frac{1}{3\,2\,5\,5}$ of an inch. No. 2, normal, $\frac{1}{3\,3\,7\,5}$ of an inch; after exposure, $\frac{1}{3\,1\,7\,5}$ of an inch. No. 3, normal, $\frac{1}{3\,3\,6\,5}$ of an inch; after exposure, $\frac{1}{3\,1\,6\,5}$ of an inch.

Upon allowing the frozen samples of blood in these cases to thaw and rise to a temperature of 80°, and then submitting the corpuscles to measurement, it was found that they had not gained in size in the slightest degree, and this remained the fact for twenty-four hours afterward.

A similar appearance to that seen on the slides of ox-blood, Fig. 2, is shown on the slides of human blood, and also the varied forms of corpuscles seen in Fig. 3.

While in the moist state these forms could be seen moving in every direction under the microscope, rolling over and over, as if alive, thus giving an opportunity to notice their forms very clearly—some of them appearing, as I have endeavored to show in the drawing, like little balls or nuclei, whence extended projections in every direction from the center as is seen in some species of diatoms or echini. These projections appear broad at the base, tapering somewhat to their rounded extremities. In many cases the blood-corpuscles seem, in contracting, to push out, from rounded centers or nuclei, processes, which project beyond the surrounding substance, as if to confirm Professor Frere's "demonstration" of blood-nuclei in contradistinction to the generally re-

Fig 3

ceived theories. Some corpuscles are seen with crenated edges, and also masses of broken corpuscles and agglomerations of fibrine, while the whole field seems alive with moving forms as shown in the figure. The large mass, showing the radiated agglomerations of blood-globules and fibrine, appeared as if anchored to the slide, while the smaller forms were moving in ceaseless rounds. As the blood is allowed to settle and dry on the slide, the forms appear to become quite flat, though in some cases projections may be seen by means of oblique illumination.

There are a few other facts in connection with this subject of contraction of the blood-corpuscles, while in the living system even, which I wish here to put on record. The cases are so few in number that they may be wholly exceptional, or it may be, perhaps, that the subject has been but little investigated in this direction.

Through the suggestion of Professor Frere, and the politeness of the officers of the County Hospital in this city, I have been for some time studying diseased blood, or rather blood from patients afflicted with many varieties of disease.

In one of these cases, pleurisy with effusion, I found the red-blood corpuscles to measure $\frac{1}{3\,3\,7\,5}$ of an inch. This is curiously near one of those cases, the blood of which was exposed to cold, as described above, in which the disks measured $\frac{1}{3\,3\,6\,5}$ of an inch.

The other case was one of ulcerated scrotum and inflamed testicle, with apparently tuberculous deposit in the gland.

On these slides, of which I have made four, may be found continuous fields of almost perfectly formed corpuscles, containing thousands of specimens which measure $\frac{1}{3\,3\,5\,5}$ of an inch, while, on the other part of the same slide, alike extensive fields of corpuscles, as perfect as the first, may be found, which measure only a fraction less than the "classic" $\frac{1}{3\,3\,6\,5}$ of an inch. The corpuscles on these slides present also the appearance of concentric circles, as shown in Dr. Cutter's photographs.—*N. Y. Medical Journal.*

DILUTION OF THE BLOOD AND FEEDING BY THE VEINS.

IN two great epidemics of cholera which I observed, says Dr. B. W. Richardson, in *Nature*, it was impossible not to see that the cause of rapid death was, in most cases, the sudden reduction of the amount of water in the body. In some instances, where all consciousness appeared to have passed away and death was declared, the recurrence of movements in the limbs of the apparently dead suggested that in the strict sense of the word there was remaining life. In some instances the effect of injecting saline solutions into the veins had such an astounding temporary effect in bringing back the consciousness, it seemed as if we had in our hands a sure remedy, if we knew how to use it, for the worst forms of the fearful malady. The practice led me to experiment on the possibility of introducing water into the body by other channels than the veins, so that it might be gradually absorbed and might re-supply what was being lost by the watery discharges from the bowels. I therefore, in 1854, injected distilled water into the cellular tissue of anæsthetized animals subcutaneously, and also into the peritoneal cavity. The difficulty of introducing any sufficient quantity into the cellular tissue prevented that method from being followed; but with the peritoneum it was different. Into the peritoneal cavity I found not only that water, at the temperature of the body can be introduced, through a hollow needle, without any danger whatever, but that the fluid is rapidly absorbed, and may be absorbed until as much as amounts to the fifth part of the weight of the animal is introduced into the organism. The difficulty I encountered, in bringing into practice this simple means of re-supplying the body with water in cholera, lay in the fear that was expressed respecting injuries to the peritoneum. The plan was nevertheless once tried in a hopeless case in the human subject in 1854, and with perfect success in promoting recovery. At the present time, with our improved instruments for injection, and better knowledge of operations on the peritoneum, the method would be certainly applied in another outbreak of acute cholera, and I believe with most successful results. Beyond the directly practical, physiology gained a point by these researches. The experiments showed that when the blood is diluted by the addition of water, beyond a fifth of the weight of the animal, *i.e.*, by the addition of a pound of water to the blood of an animal weighing five pounds, an unconscious condition of the body is induced, with sleep, with paralysis of muscle, with reduction of temperature, and with death, if the natural balance be not quickly restored. Still further by pursuing the investigation into a comparison of the specific weight of the blood, and the specific weight of a fluid excretion such as the urine, I found that in some forms of serous dropsy attended with a very low specific weight of the fluid excretions, the blood when reduced in specific weight approaching to the specific weight of the secretions, is thrown out with the utmost ease into the serous cavities by the pressure of the circulation, is not returned by the osmotic ingoing current back into the circulating channels, and so accumulates in the serous sacs, giving rise to the phenomenon of serous dropsy.

PHYSIOLOGICAL ACTION OF ALCOHOL.

A VERY large number of my researches by experimentation have had reference to the action of medicines or of chemical substances intended to be applied as foods or as medicines to the animal body. Some of these, such as chloroform, methylene-bichloride, and nitric of amyl, have already been noticed, but they are a small number compared with all that have been physiologically investigated. By subjecting animals of different species to the action of alcohol, I made clear what had only been surmised previously, that alcohol reduces the animal temperature. I also found that, like nitrite of amyl, alcohol produces what is called its stimulant action, by paralyzing the vessels of the minute circulation. By the same course of experiment I learned that the exposure of an animal to a degree of cold that is perfectly harmless when the animal is free of alcohol, is certainly fatal when the animal is narcotized from the action of alcohol. By pursuing the research so as to include in it the heavier alcohols such as butylic alcohol and amylic alcohol (fusel oil), I learned for the first time that the more injurious effects of some of the common alcoholic drinks sold for the uses of man are due to these exceedingly poisonous compounds; and by observing the action of alcohol, when the action is long continued, on the visceral organs, the various organic changes it specifically engenders, independently of all other coincidental causes of disease, were accurately determined. In a word, all my researches of a physiological kind on the action of alcohol, from which so much has been gathered in respect to the utter uselessness and the great harmfulness of that potent poison, have been made from observation of its effects on the inferior animals. Its effects in reducing temperature, in reducing vascular tension, in reducing muscular power, in destroying the action of the animal membranes, in impairing the structures of vital organs, could never have been certainly demonstrated if the lower animals had not formed the field of experimental investigation. In these experiments the lower animals suffered neither more nor less than millions of those human animals who indulge in alcohol, and I am sorry to say that, like the human animals, many of them became too fond of the agent that was producing their certain deterioration. I can but feel sure that a great number of facts of the most practical kind sprang from these researches on alcohol. To them also should be added one other addition to physiology. I traced out, in watching the effects of the heavier alcohol from the lighter of the series, the singular law that the physiological action of an organic chemical substance is intensified by the increase of its specific weight. Thus butylic alcohol is more pronounced in its action than methylic, chloroform than chloride of methyl, and so on through all the series of organic compounds.—*B. W. Richardson, in Nature.*

EPIDEMIC DISEASES AND THEIR REMEDIES.

In 1864 the death from diphtheria of one whose life was dearer to me than my own, led me to study more carefully than I had before the process of secondary absorption of secretions from diseased abraded surfaces. In the case in question I felt sure that the death was due to the absorption of poisonous secretion from the ulcerated throat and from the nasal passages. There was at that time no light to guide me to the truth except the experiments of Gaspard, Majendie, and Sedillot, which bore rather on the action of purulent matter and of decomposing blood upon the body, than on secretions formed during disease. I felt it right, therefore, to seek for further information by experiment, and this gave rise to the first steps of a research which has since assumed great importance. In the latter part of 1864 some fluid secretion had to be removed from the peritoneum of a patient suffering from surgical fever, on whom Mr. Spencer Wells had performed ovariotomy. The fluid, which was quite free from decomposition, was applied by inoculation to a healthy lower animal—a rabbit. It produced a special form of disease analogous to that from which the human patient was suffering. The secretions of the infected lower animal were tested in turn on another healthy animal, and were found to be equally and specifically poisonous. The same was extended through four series with like results. Some of the original fluid was next treated with the view of ascertaining if the poisonous principle in it could be isolated, and a series of salts were obtained which were found to possess a poisonous and progressive poisonous action like the original fluid. A poisonous organic base seemed, in fact, to be present in the peritoneal secretion, to which poison, whatever its nature might be, I gave the name of *septine*. I afterwards made a series of experiments to determine what agents destroy the activity of the poison, and from the whole of the inquiry I was brought to a theory of the epidemic diseases which I have specially announced, and which will, I believe, hold its own, viz., that these diseases are all glandular diseases, and that their poisons are specifically nothing more than the secretions of the glandular structures in a modified condition; that they may be produced with or without infection, and that they act in producing the acute symptoms of disease, after their absorption, by their effect, primarily, on the nervous system, and, secondarily, on the blood. Recently, I have endeavored to demonstrate that the fever which the septinous poisons produce is brought about by their power of liberating oxygen from the blood, and that those agents which counteract this action most effectively are the true febrifuges. As yet all such counteracting agents—one of which, quinine, is the best example—are clumsy and slow in their neutralizing effect. But chemistry has agents much more potent, and the day, I am quite sure, is not far off when we shall have given to us neutralizing agents for the contagious fevers which will be as refined and potent as the poisonous agents that produce the fevers, and which will cure fevers by inoculation from the lancet-point as certainly as small pox, or other infectious malady, is now producible by the process of inoculation of small pox septine. By and-by, and this will probably be the earliest step, we shall find a vapor, to inhale which will have the desired effect, and will be rapid in operation. This principle made perfect there will be no such thing as a necessary death from an infectious disease.

At present, the view that the poisons of the spreading diseases are merely animal secretions, like the poisonous secretion of the cobra or the changed saliva of the dog under rabies (canine madness), removes all the mystery that surrounds them, and the various plans for preventing the distribution of the poisons and of infection is rendered common sense and simple to the extremest degree.—*Dr. B. W. Richardson, in Nature.*

SMALL POX.—As an evidence of the efficacy of vaccination, the experience of a small-pox hospital at Homerton, Eng., may be cited. A lot of new servants (nurses) were engaged, of whom 27 had previously had small pox, 28 had been revaccinated, and one had not been vaccinated since childhood. The one last referred to turned out to be the only one of the lot who contracted small pox in the hospital service. In a report to the Metropolitan District Asylum Board, it is stated that of 14,800 small pox cases in the London hospitals only 4 were well authenticated instances where revaccination had been properly performed and the 4 were light attacks of the disease. Of 300 hospital attendants, the only sufferers from small pox—and they were few—were those whose revaccination had been neglected, including one case of a nurse who had previously had small pox, and caught it again.

EARS.—Professor Politzer recently put before the Medical Society of the Vienna Garrison some new proofs of the use of both ears in determining the direction of sound. People who are deaf in one ear make strange mistakes when out hunting, as they are apt to suppose that any sound comes from the direction toward which the ear they hear with may happen to be turned. A neat little experiment, easily tried, was devised by Professor Politzer. Above the top of the head of a person, whose eyes are bandaged, a watch, ticking loudly, is to be passed. The blindfolded person will be unable to say certainly whether the watch is above, before, or behind the top of his head. When one of his ears is closed, the watch seems to him to be nearest to the other ear, and this impression will still be perceptible even though the bandage be removed from his eyes. The source of sound is in general referred to a point on the right or left, according as either ear hears most loudly.

CANDELABRUM.—STYLE OF LOUIS XIV.

CANDLESTICK.—STYLE OF LOUIS XV.

CANDELABRUM.—STYLE OF LOUIS XVI.

DESIGNED BY M. J. LEFEVRE, PARIS.—(*From the Workshop.*)